Proceedings of the

HELICOPTER LOGGING SAFETY WORKSHOP

Convened by:
Alaska Interagency Working Group
for the
Prevention of Occupational Injuries

March 1-2, 1995
Ketchikan, Alaska

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HELICOPTER LOGGING SAFETY WORKSHOP

Edited by
Michael L. Klatt, M.S.
Diana S. Hudson, C.H.E.S.
George A. Conway, M.D., M.P.H.

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Working Group Co-chairs

Michael Klatt, Public Health Advisor, Alaska Field Station, Division of Safety Research, National Institute for Occupational Safety and Health

Gary Bledsoe, Manager, Occupational Injury Prevention Program, Section of Epidemiology, Division of Public Health, Alaska Department of Health and Social Services

Don Study, Former Director, Labor Standards and Safety, Alaska Department of Labor

February 1996

FOREWORD

The Alaska Interagency Working Group for the Prevention of Occupational Injuries was created by the National Institute for Occupational Safety and Health (NIOSH) (in parallel with its establishment of a research field station in Alaska), the Alaska Department of Health and Social Services (AKDHSS), and the Alaska Department of Labor (AKDOL). The Working Group was created to provide a forum for the federal, state, municipal and other public agencies responsible for worker safety to meet and exchange pertinent information in order to improve the working conditions of Alaskan workers.

The working group first met in March 1991, during the Governor's Safety and Health Conference and has met at a minimum of semi-annually since its inception. Member agencies are:

- AKDHSS
- AKDOL
- Alaska Federal Safety and Health Council
- Alaska Health Project
- Alaska Marine Safety Education Association (AMSEA)
- Alaska Safety Advisory Council
- Federal Aviation Administration (FAA)
- Governor's Safety and Health Conference
- Indian Health Service (IHS)
- Mine Safety and Health Administration (MSHA)
- Municipality of Anchorage (MOA)
- National Transportation Safety Board (NTSB)
- NIOSH
- Occupational Safety and Health Administration (OSHA)
- United States Coast Guard (USCG)
- United States Forest Service (USFS)
- University of Alaska Anchorage (UAA)

In July 1993, NIOSH requested an emergency meeting of the Working Group to address surveillance findings interpretable as representing an epidemic of helicopter logging-related fatalities. Agencies in attendance at this meeting were AKDHSS, AKDOL, FAA, NIOSH, NTSB, OSHA, USCG and USFS. The series of events that led up to this meeting and the Working Group's recommendations can be found in a Morbidity and Mortality Weekly Report article entitled "Risk for Traumatic Injuries from Helicopter Crashes During Logging Operations - Southeastern Alaska, January 1992-June 1993" (Appendix, page 110). This Helicopter Logging Safety Workshop was also a direct result of the Working Group's efforts to reduce the number of deaths among pilots and loggers involved in helicopter logging.

Michael Klatt
Public Health Advisor, Alaska Field Station
Division of Safety Research
National Institute for Occupational Safety and Health

Gary Bledsoe
Manager, Occupational Injury Prevention Program
Section of Epidemiology
Alaska Department of Health and Social Services

Don Study
Former Director, Labor Standards and Safety
Alaska Department of Labor

ACKNOWLEDGMENTS

Convening the Helicopter Logging Safety Workshop was a team effort as was preparing these *Proceedings*. In addition to the planning committee, the presenters and the session moderator, we wish to thank the following staff and editorial advisors for their diligent work at this Helicopter Logging Safety Workshop, and for their help in the preparation of this document.

Foremost in our appreciation, we thank Mr. Jan Manwaring for his lead role in securing the speakers for this Workshop and developing its agenda. He is also to be commended for the excellent job he did in refining and clarifying the final recommendations.

We also thank Ms. Linda Ashley, who has worked with dedication and superb attention to detail in all phases of the publication of these *Proceedings*. She is responsible for the completeness of this document.

Thanks are given to Ms. Jennifer Lincoln for preparing many of the graphics, and Dr. Marvin Bailey for his careful reading of the document and many suggestions for improvements to this document. We are also very grateful to Rick Kelly's expert support with computer hardware and software.

To the contributors, a special thanks is extended for their review of the transcripts of their respective presentations and for their responsiveness to every question.

United States Senate

WASHINGTON, DC 20510

March 1, 1995

To the Participants in the
Helicopter Logging Workshop
The Alaska Interagency Working Group for
the Prevention of Occupational Injuries
The Cape Fax-Westmark
Ketchikan, Alaska 99901

Good luck in your workshops. Thanks for providing me with your agenda.

Working together, I'm confident you will continue toward the goal of a zero accident rate in the helicopter logging industry.

NIOSH has done a fine job of providing safety awareness and education. Your agenda over these two days, sharing your information and experiences, will add to what NIOSH has contributed.

The hard-working men and women in Alaska's timber industry deserve every help possible to keep them safe. Thanks for the work that you do to maintain their safety.

With best wishes,

Cordially,

Ted Stevens
U.S. Senator

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EXECUTIVE SUMMARY

by Michael Klatt

The Alaska Interagency Working Group for the Prevention of Occupational Injuries convened the Helicopter Logging Safety Workshop in Ketchikan, Alaska, on March 1-2, 1995. The purpose of the Helicopter Logging Safety Workshop was to increase awareness, build coalitions, share information and experiences, and encourage action to prevent injury in the helicopter logging industry. This Executive Summary encapsulates the *Proceedings of the Helicopter Logging Safety Workshop.* Each presentation is summarized in the order in which it was given.

Dr. George Conway, Chief, Alaska Field Station, Division of Safety Research, NIOSH, presented "Epidemiology of Alaska Helicopter Logging Deaths." Dr. Conway began by briefly discussing the six recent helicopter logging crashes in Alaska that resulted in this workshop being convened. The epidemiological analysis of these events demonstrated the following: an annual crash rate of 16% for Alaska logging helicopters; one death annually for every four logging helicopters that were in service; and an annual fatality rate for logging helicopter pilots of approximately 5,000 per 100,000 per year (or one in 20 of the pilots were killed per year). He went on to state that investigation revealed that all six crashes involved improper operational and/or maintenance practices.

Mr. Jan Manwaring, Safety Specialist, Alaska Field Station, Division of Safety Research, NIOSH, presented a "Synthesis of NTSB Aircraft Accident Data Involving Helicopter External Load Operations in the United States and Alaska, 1980-1994." The NTSB data showed the severity of the helicopter crash injuries to be much greater with heli-logging than with all other external load operations. The same data showed heli-logging crashes in Alaska to be evenly divided between maintenance error and pilot error, and that maintenance error is much more a factor in Alaska than the rest of the U.S. He concluded that to minimize the hazards of helicopter logging, pilots need better training; helicopters and equipment need improved design, as well as more frequent and intensive maintenance; and operators must adhere to existing regulations and manufacturer recommendations.

Mr. Gary Bledsoe, Manager, Alaska Occupational Injury Prevention Program, presented the "Public Health Approach to Preventing Helicopter Logging Injuries." He discussed the public health approach as it is traditionally used to control infectious diseases and how this same methodology is used in injury prevention. The injury triad of the host as the worker, the agent as the energy source and the environment as the workplace, was explained to show the interrelationship of these three factors in preventing injuries. He explained the Time-Phase Matrix, or Haddon's Matrix, that is used to break down an injury event for analytical purposes into the pre-event, event, and post-event phases.

Mr. Mark Lindamood, Chief Pilot, Carson Helicopters, shared his views on "Helicopter Logging from a Pilot's Perspective." He described the crashes and injuries he has experienced and listed the names of several pilots killed in single-engine helicopter crashes. He noted that, on the other hand, the large, twin-engine helicopters with two engines, two inputs, two servo systems, two electrical systems, two fuel systems and two pilots were designed to carry heavy external loads safely. If one power plant fails in a twin-engine helicopter, a safe landing can be achieved with the remaining one. Having two pilots increases safety dramatically by reducing pilot fatigue and by allowing one pilot to fly and the other to perform all the other required tasks. It was this presenter's opinion that, "Single-engine helicopters must be prohibited from performing external load work."

Mr. Dale Hoke, Owner, Aerial Crane Systems, Inc., presented "Alternative Aerologging Techniques." He described an aerial crane system consisting of an aerostat tethered to four light weight lines, each controlled by a winch. The prototype proved to be extremely easy to operate with great proficiency. He also found that the prototype couldn't be over-torqued, over-extended or tipped over and that the long-line hook assembly was very stable. It could be operated at night, in fog and at about a quarter of the cost of an equivalent-sized helicopter. For these reasons, and the fact that it can be operated from the ground, this aerial crane system may prove to be much safer and less expensive than helicopter logging in certain yarding operations.

Mr. Roy Fox, Product Safety Chief, Bell Helicopter Textron, Inc., addressed "Helicopter Logging Safety: Manufacturer's Concerns." He stated that operators with good safety records tend to own their own aircraft, operate and maintain them properly, use approved parts, and ensure adequate rest for their employees; conversely, operators with poor safety records tend to exceed operating parameters, use salvage and/or surplus parts, and fly in bad weather. Military surplus helicopters have a poor safety record because once in use as surplus they tend to be cheaply maintained, attract surplus, counterfeit and salvaged parts, and are doing jobs with poor economic prospects. A poorly capitalized operation will tend to use overworked and under-qualified pilots. He further stated that abusive use beyond what the helicopter was designed for causes in-flight part failures. He stressed that to reduce risk, operators should use helicopters and parts designed for the environment; follow the manufacturer's maintenance and operating requirements; allow adequate rest for the flight and maintenance personnel; not use military surplus aircraft or parts; and never exceed the external load limit.

Mr. Phil Kemp, Maintenance Director, Silver Bay Aviation, discussed "Weather and Terrain Hazards in Helicopter Logging." He stressed that although weather and terrain are separate natural features, they are inextricably combined. Most helicopter logging takes place in steep, rugged terrain, placing ground crew in increased danger and making emergency landings and rescue attempts extremely difficult. Water on rotor blades can cause erosion, and water in the fuel system can cause flame-out and power loss. Icing affects engines and rotors, degrading the performance of both. Wind affects helicopter logging both positively and negatively.

Mr. Ron Smith, Maintenance Foreman, Erickson Aircrane, addressed "Helicopter Maintenance in Helicopter Logging Operations." He pointed out that finding qualified mechanics for helicopter maintenance is extremely difficult; therefore, most training is conducted on-site. Because helicopter logging is such an arduous task, stress from the constant vibration shows up on just about everything on the aircraft, necessitating frequent and thorough inspections. Logging with helicopters tends to identify the weak areas in an aircraft's design; therefore, Erickson Aircrane mitigated or eliminated many of the design flaws resulting in dependable logging helicopters that can fly for prolonged periods reliably. These modifications are shared with other operators. Although a lack of trained inspectors is a weak link in the industry, when maintenance is a company-wide priority, everybody contributes to overall safety.

Mr. Don Study, Former Director, Labor Standards and Safety, Alaska Department of Labor discussed "Regulations and Standards in External Load Operations." He stressed that although bad operators may crash themselves out of business, it's the whole industry's insurance rates and reputation that are adversely affected. The Alaska Department of Labor only has jurisdiction over the ground operations, so it cannot enforce FAA regulations that apply to flight operations. It is the industry people attending this workshop who are in the best position to police or, if need be, make recommendations to the appropriate regulatory agencies to improve the safety of the industry. He stated that, after all, most of OSHA's standards and regulations were initiated by industry.

Mr. George Warren, Chief Pilot, Columbia Helicopters, Inc., presented his views on "The Business of Helicopter Logging." He pointed out that one of the essential aspects of efficient helicopter logging is safety. The cost of operating large helicopters is enormous, and can come as quite a shock to operators of small and intermediate-sized aircraft, who try to extrapolate their costs and operating experience with smaller machines up to logging-sized helicopters. The reality is that helicopter logging is a marginal endeavor, with profit margins averaging a few percent. The crucial ingredients to the success of their industry have been the willingness of an innovative management to commit resources on a long-term basis to make heli-logging safe and effective.

Mr. Randy Erwin, Chief Pilot, Erickson Aircrane, presented "Helicopter Adaptations for External Load Operations." It is his opinion that long-line logging may be the most unique application for the helicopter and that external load and vertical reference skills are the most demanding in the helicopter industry. Bubble windows, outside instruments, load cells that tell the pilot how much weight is on the hook, left hand seats, remote hooks that allow the pilot to control what's going on at the end of the hook, and logging shocks are examples of adaptations to helicopters that have made helicopter logging safer. He asserted, "You can't do this business without being safe and efficient, because it's just too expensive."

Mr. Jim Neal, Safety Manager, Aerial Forest Management Foundation, presented "Helicopter Logging from a Ground Crewman's Perspective." It is his opinion that from a ground crewman's perspective, helicopter logging is the safest form of logging in the woods. He stated that everybody out there has visual and radio contact with the yarding engineer or pilot at all times and nothing moves until he permits it. He further stated that if the helicopter logging industry doesn't want government to impose new rules and regulations upon it, then it must police itself, and that the people with the answers to this industry's problems are attending this workshop.

Dr. Robert Bertoldo, Flight Surgeon, United States Air Force, spoke on the "Operational and Aircrew Factors in Helicopter Application." He stated emphatically that helicopters are inherently deadly. According to NTSB data, helicopters have a crash rate 15 times that of all other aircraft. The United States Air Force feels that by applying existing technology, 95% of the current helicopter crashes could be survivable. He went on to state that wind is the number one weather-related cause of helicopter crashes and that fog, low ceiling and rain are the primary causes of fatal crashes. There are three determinants of pilot performance: ability, personality, and attitude. Basically, there is no substitute for pilot experience, but even with experience, there's a need to keep coming back to the basic airmanship skills.

Mr. Doug Herlihy, Former Crash Investigator, National Transportation Safety Board, presented "Investigation Findings of Helicopter Logging Crashes." He described in great detail one of the logging helicopter crashes that resulted in this Helicopter Logging Safety Workshop being convened. He stated that no aircraft crash is caused by just one event; it's a causal string of events, like dominoes. NTSB crash investigators look beyond the violation of FAA regulations for the causes of aircraft crashes. From his experience he has found only three scenarios that will kill the occupants of helicopters that crash: 1) the cockpit/cabin is penetrated or crushed; 2) the occupants are burned or asphyxiated; or 3) they are exposed to g forces beyond human tolerance limits.

EPIDEMIOLOGY OF ALASKA HELICOPTER LOGGING DEATHS

By George A. Conway, M.D., M.P.H., Chief, Alaska Field Station, Division of Safety Research, National Institute for Occupational Safety and Health (NIOSH)

First, I want to acknowledge Mike Klatt and Jan Manwaring for doing a tremendous amount of work to set up this workshop. I'm glad to see almost all of the chairs full, and that many people have come in from far afield.

I also want to acknowledge all of the agencies (Figure 1), that we've worked with in setting up occupational injury surveillance for Alaska, and that have provided quite a bit of the information that we'll present here.

I'm a public health physician with training in epidemiology and setting up surveillance systems, which are systems to detect injuries and diseases, and in applying this information to prevent similar events from happening in the future.

Our office studies the occupational risks involved in working in Alaska by: setting up surveillance and reporting systems; conducting prevention-oriented research; and looking, in particular, at high risk operations and occupations. In Alaska, those are commercial fishing, air transport, and logging. And, of course, in helicopter logging we have the combined risks of air transport and logging, both of which operations contribute to the unique hazards of this activity. We also evaluate how well interventions work in Alaska as a possible example for how to do things elsewhere in the country, and promote worker injury prevention technology.

Because of the unique capabilities of helicopters, they are being used increasingly by logging companies in Southeast Alaska to harvest timber, owing to driving forces of rugged terrain, the poor traction afforded by steep mountain slopes, increasing environmental restrictions, and economic factors. The growth of this industry also reflects a trend in tropical rain forest logging, ranging as widely as Amazonia and Southeast Asia.

In plantation logging in the southeastern U.S., a new large-scale agreement was recently made between the Nature Conservancy and a logging consortium to do solely helicopter logging in a number of disputed, semi-protected areas, and it is hoped that similar agreements will keep the peace in certain old-growth Pacific Northwest forests. Now, any time that you have an evolving, complex operation, that can pose new hazards.

These bar charts (Figure 2) show the number of fatalities in the height (y-axis) of the bars, and then across the bottom (x-axis), the occupations. Fishing accounts for the highest number of occupational fatalities in Alaska, followed by pilots, as well as loggers and guides.

One of the first questions we asked, was whether or not the high number of deaths in Alaska was inevitable because of the harshness of the terrain, the climate, the length of the winter, etcetera. We looked at the occupational fatality rate in Alaska, which is 35 per 100,000 workers per year, which we knew was roughly five times that of the United States, and we compared it (Figure 3) to the other developed northern nations with national occupational mortality surveillance, the Nordic nations: Sweden, Denmark, Norway, and Finland. And what we realized was that even though they have similar climates to Alaska, and logging and fishing played major roles in their economies, especially in Norway, Sweden, and Finland, the rates at which those nations were experiencing occupational fatalities were much lower, not only lower than in Alaska, but than in the United States itself. So, we reject the idea of the inevitability that working in Alaska has to be more dangerous than elsewhere, and assume that that is always a combination of not having adequate design and not having the best practices when mishaps occur.

The surveillance system which we've set up (Figure 4) provides a means of gathering and pulling together information that many other groups compile, ranging from agencies to industry. Foremost among contributors to the data I will show here today are the National Transportation Safety Board (NTSB), the Alaska Department of Labor, the U.S. Coast Guard and the Federal Aviation Administration (FAA).

We also receive information from the Indian Health Service; the Alaska Office of the Medical Examiner, where we get coroners' and medical examiner reports, which often provide us very good information on the occurrence, as well as important information like toxicologic information, like whether or not there was alcohol in the blood of the decedent; the Alaska State Troopers; the Alaska Trauma Registry, which is operated by the Emergency Medical Services Section; and the Section of Epidemiology of the Alaska Department of Health and Social Services. In particular, we collaborate closely with Dr. John Middaugh, the State Epidemiologist, and Gary Bledsoe, also of the Alaska Department of Health and Social Services, and who is with us today. We also have data-sharing agreements with: the Alaska Bureau of Vital Statistics, from which we get death certificates; the Occupational Safety and Health Administration (OSHA); and municipal and local public safety officials, including Village Public Safety Officers.

I'll now review highlights of the six incidents that prompted the flurry of activity that many of us were involved in about a year and a half ago. The first incident occurred just about three years ago, on February 23rd, 1992. The helicopter crashed while it was transporting nine loggers as passengers. The copilot and five loggers were killed. The pilot and four loggers were seriously injured.

The NTSB investigation revealed that a load cable long-line attached to the belly of the helicopter became entangled in the tail rotor during a landing approach, and that caused an in-flight separation of the tail section, with the subsequent crash. The NTSB report emphasized that passenger flights with long-line and external attachments are contrary to law and industry safety standards. So, this was the serious and signal event which drew people's attention to the hazards of this industry in Alaska.

Not long after that, on March 2, 1992, a helicopter crashed while it was preparing to pick up a load of logs with a long-line while in a 200-foot hover. The pilot and copilot were seriously injured. According to the crew, the engine experienced a complete mechanical failure and power loss. Immediately afterward, the pilot released the external log load and attempted to autorotate. The NTSB revealed that a hole in the side of the rear section of the engine case had occurred at the time of the engine failure.

On November 10th, 1992, a helicopter crashed while attempting to land at a logging site and sustained substantial damage to the machine. The solo pilot wasn't injured. The NTSB investigation revealed that the helicopter's long-line had snagged on a tree stump during the landing. Their investigation further revealed that the company had no documented training program.

On February 19th, 1993, a helicopter crashed from a 200-foot hover after transporting two logs to a log drop area. The pilot and copilot were killed. The NTSB investigation revealed an in-flight fatigue failure of a flight control piston rod. Evidence indicated that log loads routinely carried by the helicopter exceeded the aircraft's weight and balance limitation. Further investigation by the NTSB and our own interviews of survivors indicated that this may have been a common practice. Laboratory examination of the flight control hydraulic system revealed a degree of binding and wear not consistent with a normal overhaul.

The next event is particularly important to talk about in detail. On May 2nd, 1993, a helicopter crashed during an attempted emergency landing, after having used a long-line to lift logs to an altitude of 1,200 feet, and then rapidly descending to a 75-foot hover. The solo pilot was killed and a ground crewman was injured.

The NTSB investigation revealed in-flight separation of the tail rotor and the tail rotor gear box from the helicopter. Log loads routinely carried by the aircraft had exceeded its weight and balance limits. On the day of the crash the company was reportedly using a procedure that would have heavily loaded the helicopter drive train: autorotating with a heavy external load, from a point near the logging site, to a drop point at a lower altitude, where a full power recovery to a hover was executed before dropping the external load. Records show that the helicopter gear box had been purchased by the company as surplus from the U.S. Army, which had removed it from service in 1986 because of excessive wear.

There are a number of key features of this event that represent the types of areas that we'd like to focus on: improper use of the machinery; controlled or semi-controlled autorotation maneuvers while loaded, which may not be an appropriate practice; and other problems with equipment and oversight. Also, the human factors, including stress and task fatigue, which occur from the frequent and prolonged repetition of a highly complex task, likely contributed to this event. Poor capitalization of this company may also have contributed, by leading to the acquisition of worn equipment and inadequate and/or untrained staffing.

On May 8th, 1993, a helicopter crashed after attempting to lift a log from a logging site with a long-line. While the pilot and copilot sustained minor injuries, the aircraft was substantially damaged.

The subsequent investigation revealed that company maintenance personnel had recently installed the engine in the field, in an unheated hangar, and the engine failed due to the ingestion of loose metal nuts. Immediately following engine failure, the helicopter autorotated and impacted on a 30 degree slope that was covered with stumps and logs. The log load weights for flights over the preceding two weeks had substantially exceeded the maximum authorized for that helicopter.

This is a tabular summary (Figure 5) which we put together right after this last event, which summarizes that there were a total of nine people killed in this year and a half period, that there were also ten people with serious enough injuries to require major medical care, the type of helicopter involved, and the logging company: there were two different companies that were involved in these events. I have also arranged features of these events in a time-phase or Haddon's Matrix (Figure 6). As you can see, these events are often the result of the interaction of many different factors.

This is a height-velocity curve, sometimes referred to as "dead man's curve" (Figure 7), for the primary piece of equipment that was involved, which we referred to as helicopter equipment A in the previous table. All of these helicopters which crashed were essentially at a hover or near hover when these events occurred, and none of them had sufficient altitude to successfully autorotate downward. This raises the question of whether the best practices might involve having a larger portion of operations occur higher up, or having something (e.g., second degree, or impact attenuation system) that would render these occurrences more survivable when they're at heights of say, 200 feet or less. Certainly, a very large percentage of current heli-logging operations take place in the very high-risk portion of the height-velocity curve.

During this one-and-a-half-year period, from the beginning of 1992 through mid-1993, FAA records indicated that there were an estimated 25 helicopters in Alaska that were capable of conducting sling load logging operations. The reason there was not an exact tally has to do with the licensure and registration practices, which don't require local certification. Approximately 20 of the helicopters then in use in Alaska were single-engine models from one manufacturer (the other five were dual-engine models), and there were approximately 50 helicopter pilots, based on a synthesis that we did of FAA and Alaska Department of Labor estimates, employed in sling load logging operations in Alaska, nearly all of those here in Southeast Alaska.

The events reported here are then equivalent to an annual crash rate of 16 percent, which we believe is the highest reported in any flight-related industry, including support activities in some theaters of war. We understand that it's in excess of the rate that occurred for rotary aircraft transportation operations during the war in Viet Nam. So, this is just an extraordinary crash rate, .24 deaths per sling load helicopter in service per year, or a death annually for every four helicopters that were in service. These events resulted in a sling load logging helicopter pilot annual fatality rate of approximately 5,000 per 100,000 pilots per year, or one in 20 of the pilots killed per year, which is just extraordinary and really unprecedented in any legitimate occupation in this half of the century that's been documented in the scientific literature. All nine workers who died were males, with an average age of 38 for loggers and 43 for pilots.

After the sixth event, on July 8th, 1993, an emergency meeting was held of the Alaska Interagency Working Group for the Prevention of Occupational Injuries. That meeting included Alaska Department of Labor, Alaska Department of Health and Social Services, FAA, NTSB, Coast Guard, OSHA, the Forest Service, and our own staff.

In response to the crash, fatality, and injury surveillance data, the working group developed consensus safety recommendations and encouraged immediate improvements in the oversight and supervision of this industry. Since these recommendations were made in July of 1993, and the implementation of more stringent site-specific oversight during the summer of 1993, there have been no additional helicopter logging fatalities in Alaska.

Our consensus recommendations included the following: All helicopter logging pilots and ground crews should receive specific training in long-line operation. Each company should follow all manufacturer's recommendations for more frequent helicopter maintenance, because of intensity of use and for limits on maximum allowable loads. Each company should establish and observe appropriate limits on helicopter crew flight time and duty periods. This addresses a major concern about highly repetitive action and cumulative fatigue on the part of flight staff and also ground staff. Each company should consider using multi-engine rotor craft in case of a single-engine failure. Specific industry-wide operating standards and procedures should be developed. All companies should provide training in on-site emergency medical care for helicopter logging crews at all work locations. This recommendation was made because of weaknesses identified in the immediate first aid and medical care that some of the individuals injured in these events received. We further recommended that state, regional, and local agencies involved in emergency medical services and education should make low-cost emergency medical training available to persons likely to work in helicopter logging environments. Lastly, we recommended that all flights over water should include appropriate survival equipment for all crew and passengers. These personnel should wear personal flotation devices at all times during flights over water. I have superimposed these recommendations on the same time-phase matrix I used to present risk factors (Figure 8). You can see that we have chosen a strategy of primarily trying to prevent, rather than mitigate, crash events.

In summary, what we have seen in Alaska is an extraordinary increase through the early 1990s in the number of serious crash events associated with helicopter logging. My last graphic (Figure 9) shows the number of events by year, with the blue being the number of crashes; red, number of fatalities; and green, severe, non-fatal injuries. As you can see, in 1994 there was a sudden decrease in these events. However, we're not convinced that the problem has, by any means, been dealt with definitively in Alaska.

The number of companies involved is very limited now. Those that remain involved appear to be engaged in very good practices, as companies "A" and "B" are no longer in business in Alaska. However, we're not aware of any restraint on other companies that might not engage in such good practices entering this work place and this industry in the future.

What I'll leave you with is the charge: I challenge each of you to do everything that you can to work together to make aerologging operations safe, both by increasing our understanding of the hazards, and by sharing our understanding of these. We should do this by exploring and actively promoting ways to reduce or eliminate these hazards, while maintaining the viability and the vitality of this rapidly expanding industry.

Acknowledgments

- Alaska Commercial Fisheries Entry Commission
- Alaska Department of Fish & Game
- Alaska Department of Health and Social Services
  - Bureau of Vital Statistics
  - Emergency Medical Services
  - Section of Epidemiology
- Alaska Department of Labor
  - Bureau of Labor Statistics
  - Labor Standards and Safety Division
- Alaska Marine Safety Education Association
- Alaska State Troopers
- Federal Aviation Administration
- Federal Occupational Safety and Health Administration
- National Institute for Occupational Safety and Health
- National Marine Fisheries Service
- National Transportation Safety Board
- North Pacific Fishery Management Council
- University of Alaska
- U.S. Coast Guard

Figure 1

Fatalities by Occupation, Alaska, 1990-1994, n=365

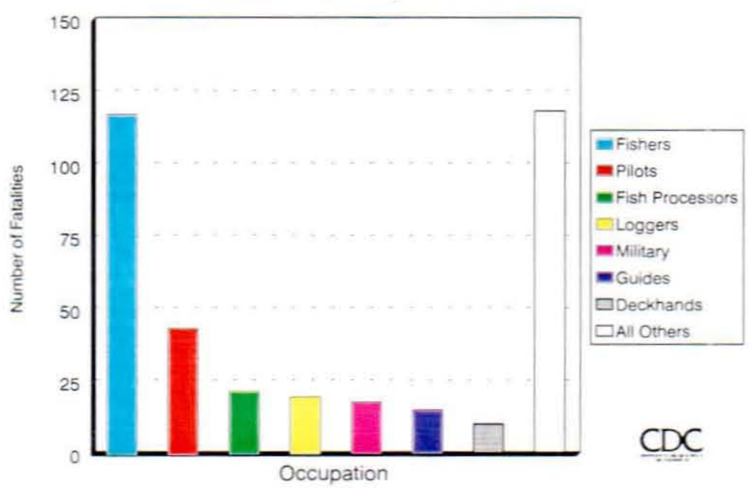


Figure 2

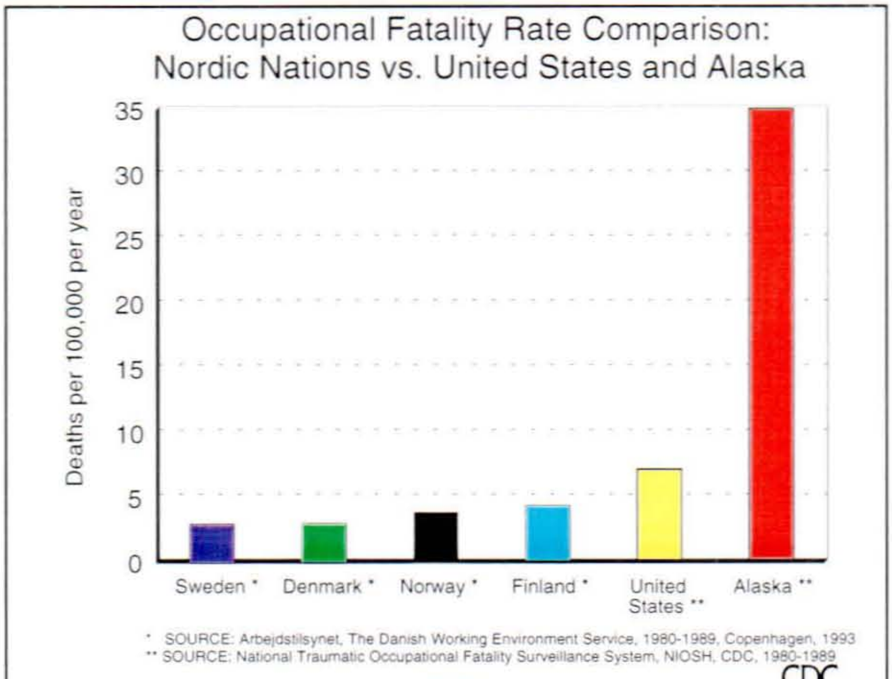


Figure 3

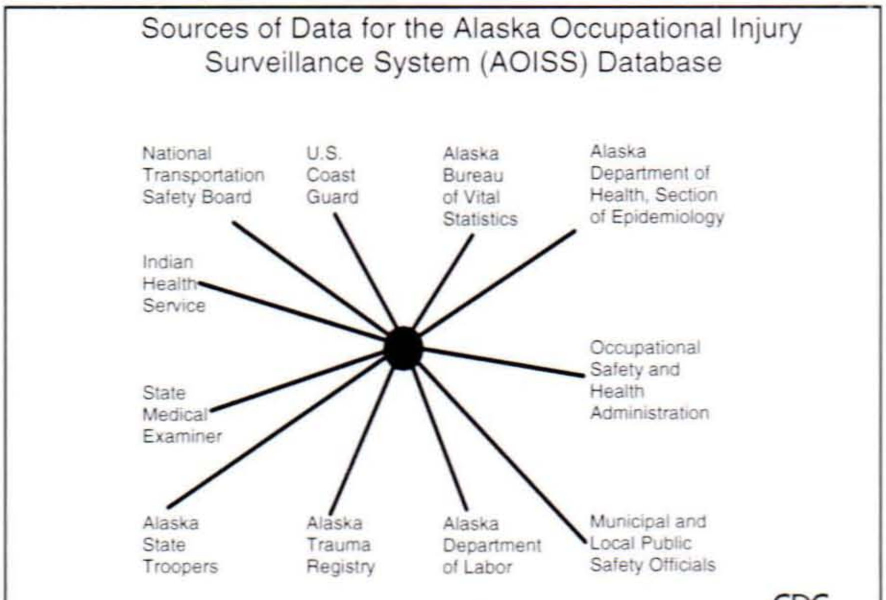


Figure 4

Helicopter Logging Incidents, Alaska, 1992-1993

Date	# Killed	# Injured	Type of Helicopter	Logging Company
2/23/92	6 (co-pilot and 5 loggers)	5 (pilot and 4 loggers)	Manufacturer A, type A Single-engine	Company A
3/6/92	0	2 (pilot and co-pilot)	Manufacturer A, type A Single-engine	Company A
11/10/92	0	0	Manufacturer A, type B Single-engine	Company A
2/19/93	2 (pilot and co-pilot)	0	Manufacturer A, type A Single-engine	Company B
5/2/93	1 (solo pilot)	1 (ground crew logger)	Manufacturer A, type C Single-engine	Company B
5/8/93	0	2 (pilot and co-pilot)	Manufacturer A, type A Single engine	Company B

Figure 5

Features of Alaska Helicopter Logging Injury Events (after Haddon)

	Host/Human	Agent/Vehicle	Environment
Pre-event/ Pre-injury	Pilot Training , Experience, Fatigue, Stress, Rx, illegal drugs Alcohol Ground crew Training Experience	Helicopter design Lift, durability; Maintenance & repairs Engines & controls Ergonomics Unstable work platform; Surplus/improvised equipment	Terrain Weather Landing zones Oversight FAA (CFR pt 133) industry
Event/Injury	Pilot Reaction to emergency situation (i.e. autorotation), Task overload Ground crew Reacting, avoiding	Helicopter Autorotation performance: deformation on impact; Fires & explosions	Terrain Weather
Post-event	Types of injury, severity		Little assistance available EMS not available

Figure 6

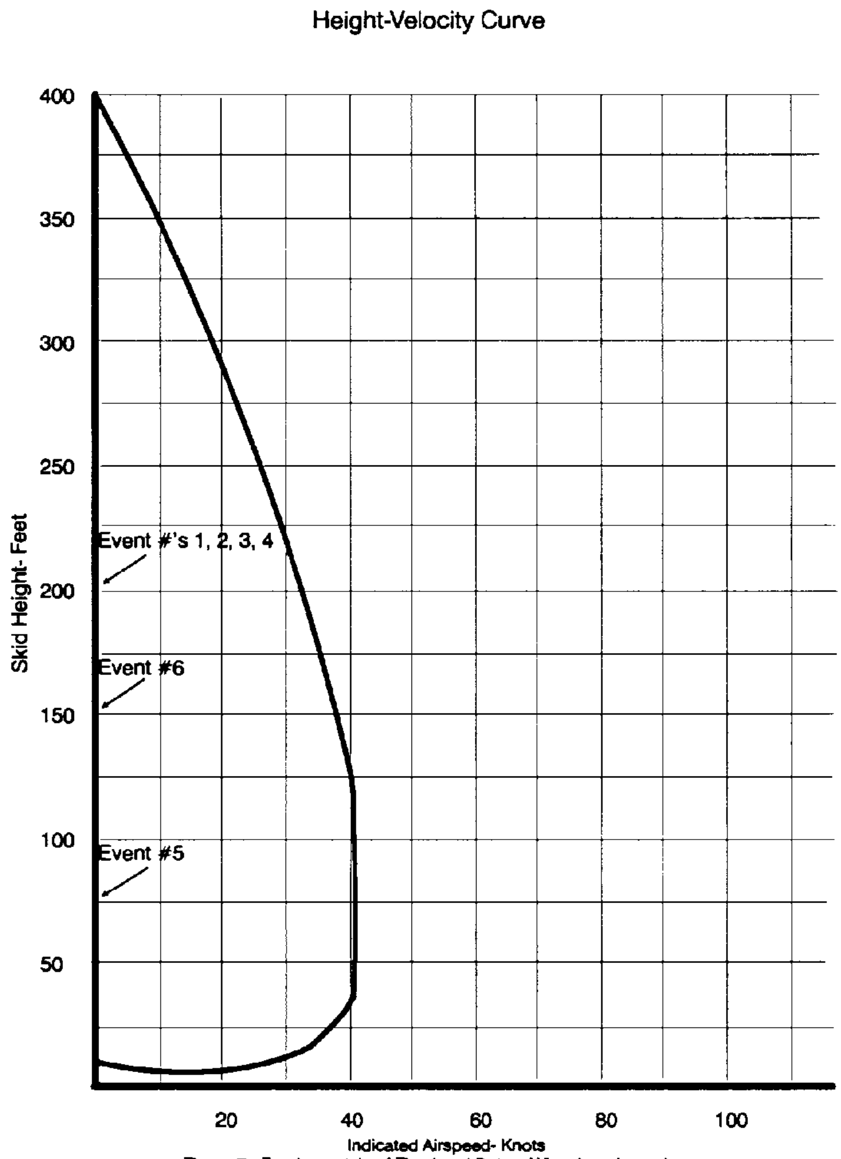


Figure 7: Fundamentals of Fixed and Rotary Wing Aerodynamics
Adapted from curve illustrated in Part I Fundamentals of Fixed and Rotary Wing Aerodynamics
by H.E. Roland, Jr. and J. F. Detweiler, University of Southern California, November 1967

Alaska Helicopter Logging Injury Recommended Countermeasures (From Alaska Interagency Working Group for the Prevention of Occupational Injuries, July, 1993)

	Host/Human	Agent/Vehicle	Environment
Pre-event/ Pre-injury	Increased training for pilots and ground crew Improved work/ rest cycles	Maintenance per manufacturer's recommendations, Impact (g)- resistant seats NTSB- to prohibit surplus equipment	Improved interagency communication, Increased FAA oversight
Event/Injury	Practical training in autorotation		Emergency (backup) landing zones
Post-event			

Figure 8

Crashes, Fatalities, and Non-fatal Injuries in Alaska Helicopter Logging Operations, 1989-1994

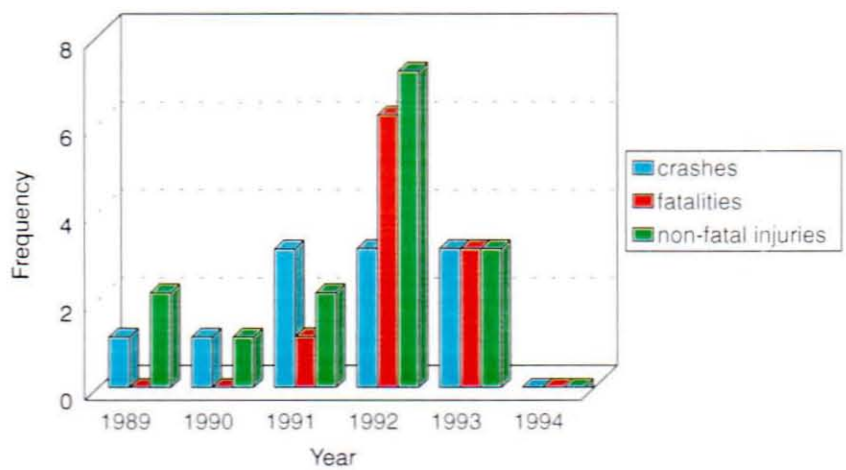


Figure 9

CDC

SYNTHESIS OF NTSB AIRCRAFT ACCIDENT DATA INVOLVING HELICOPTER EXTERNAL LOAD OPERATIONS IN THE UNITED STATES AND ALASKA, 1980-1994

By Jan Manwaring, Safety Specialist, Alaska Field Station, Division of Safety Research, National Institute for Occupational Safety and Health (NIOSH)

I'd like to preface my presentation with two comments. Although some people confuse NIOSH with OSHA, and both were established by the Occupational Safety and Health Act of 1970, the two are not the same. OSHA, the Occupational Safety and Health Administration, is a regulatory agency within the U.S. Department of Labor; NIOSH, the National Institute for Occupational Safety and Health, is a research organization within the Centers for Disease Control and Prevention, located within the U.S. Public Health Service of the Department of Health and Human Services. However, NIOSH does have a very important relationship with OSHA, which is somewhat similar to the relationship NTSB has with the FAA. One of NIOSH's responsibilities is to make recommendations to OSHA which are based on investigative scientific research in occupational safety and health, as NTSB provides recommendations in the development and promulgation of FAA standards.

My second comment has to do with the use of the term "accident." NIOSH, the Centers for Disease Control and Prevention, and our Division of Safety Research try to avoid using the word because it has the connotation of a randomly occurring event with an unfortunate and unpreventable outcome. However, most safety professionals maintain that most if not all "accidents" are preventable. We at NIOSH believe this as well. However, we do appreciate that NTSB and FAA have a specific definition for the term "accident" -- an aircraft crash or mishap resulting in a serious human injury or fatality and/or substantial aircraft damage or destruction. Therefore, since I am using NTSB "accident" data in my presentation, I will be using the term "accident" throughout my presentation.

We reviewed NTSB data from 1980 through 1994, compiled from a database of information from the NTSB's Accident Briefs of CFR Part 133 (involving helicopter external load operations), in the U.S. to examine common factors for all known heli-logging accidents and crashes investigated by the NTSB during this time period. There were 220 such accidents known, of which 214 (or approximately 97%) were considered crashes. It should be understood that crashes and accidents are not interchangeable words for the purposes of this study.

For the purpose of this study, "crashes" are a subset of accidents that involve impact of the helicopter body or its parts, resulting in serious injury or fatality to humans, and/or damage or destruction of the aircraft. Several accidents in the NTSB data base which have been computed into the fatal accident and fatal/serious injury rates did not involve helicopter impact-type accidents, and thus were not included in fatal crash and fatal/serious injury rates. For example, four accidents included in the non-helicopter logging-related accident rates did not constitute crashes, and were thus not used when computing similar crash rates. In one case, a ground crew member was injured when he went into a drop zone as a pole was being lowered. In another, a worker suspended on a long-line was electrocuted, but a crash did not occur. In yet another accident, a passenger fell from a wheel strut and was killed, but again, no crash or impact injury resulting from a downed aircraft occurred. Finally, in a 1985 case, a ground worker was killed when a sling broke and dropped a block of wood on him. This event was also not classified as a crash. In computing the long-line logging helicopter serious injury and fatality crash rates, we excluded two of the 64 accidents nationally that were not crashes. In one case, two workers fell (fatally injuring one) while being transported, and in another, a piece of wood fell from the long-line and struck and killed a member of the ground crew. While these six non-crash accidents demonstrate some of the risks of long-line helicopter use, especially those of non-secure transport of personnel and material, they are not considered impact-type crashes. Perhaps the most notable findings involving NTSB data are those that reveal the most common probable causes and other common factors contributing to these helicopter crashes.

Since denominator data in helicopter logging are not readily available for determining rates, I'm afraid my presentation will ask more questions than it will answer. That's one of the reasons we are sponsoring this workshop -- to help us assess the risks and prevent the injuries associated with heli-logging. We would like to find answers to questions including: How many helicopters, pilots and flight hours are there involved in heli-logging in the U.S.? How many of the heli-logging flights are conducted in single versus twin-engine helicopters? How many of the heli-logging flights are conducted by one versus two pilots? And, most importantly, perhaps, what is your interpretation concerning the overall picture of long-line helicopter operations, as demonstrated by this NTSB data?

Our study methodology was as follows: from each of these NTSB "Accident Briefs," we abstracted for 62 variables and entered them into a database. We found that of the 147 events for which flight purpose was available (of 220 total external load accidents), 64 (43.5%) occurred during helicopter logging operations and represent the largest portion of helicopter external load accidents by type of operation (Chart A). These 64 accidents resulted in 24 fatalities, of which 17 were pilots, five were loggers being transported as passengers in one crash event, and two were ground crew involved in two separate accidents. As shown in Chart B, it is important to note the difference between the percentage of crashes which were fatal (23%) and the rate of fatalities per crash (.35 mean). In the computation of fatality crash rates (14 crashes involving at least one fatality out of 62 total crashes) only one fatality "count" is made for each crash, regardless of the actual number of people killed.

Charts B, C, D and E demonstrate the magnitude of the problem in terms of helicopter logging crashes that resulted in fatal *and* serious non-fatal injuries. If we combine the crashes that resulted in at least one serious non-fatal injury with the 14 fatal crashes, then we get a combined total of 31 such crashes, or a fatal/serious non-fatal crash injury rate of 50%. The severity of helicopter crash injuries appears to be much greater with heli-logging than with all other helicopter external load operations. [Fatal crash rates respectively of 23% (Chart B, heli-logging) versus 16% (Chart D, non-heli-logging) and combined fatal/serious non fatal crash injury rate of 50% (Chart C, heli-logging) versus 36% (Chart E, non-heli-logging) respectively.]

When we examine NTSB heli-logging data for Alaska only, the picture becomes even more tragic. All heli-logging accidents in the state were considered crashes because they involved helicopter impact-type injuries. Of 15 heli-logging-related crashes in the state, five crashes resulted in at least one fatality, or a fatal crash rate of 33%. The same 15 heli-logging crashes resulted in 11 fatalities, or a rate of .73 (mean) fatalities per crash (Chart F). Alaska also had an additional four crashes in which there was at least one serious non-fatal injury for a combined fatal/serious crash injury rate of 60%. The 15 heli-logging crashes resulted in 22 fatal and serious non-fatal injuries (11 fatal and 11 non-fatal, as shown in Chart G). Does this say something about the non-suitability or availability of emergency landing sites for helicopters involved in heli-logging operations in Alaska?

When we examine the distribution of all U.S. heli-logging accidents by month (Chart H), we see that the majority of accidents occur during warmer weather, which is when most heli-logging operations are conducted. Although denominator data for both the number of pilots and helicopters involved in heli-logging is lacking, it is suggested that the main reason for the increased number of accidents during the spring and summer months is the increase in the amount of heli-logging operations during that time of year, not that these operations are inherently more hazardous during the spring and summer. In looking at the distribution of Alaska accidents, it is interesting to note the peak has occurred in May.

Chart I shows heli-logging accidents by state. Alaska leads the U.S. in the number of heli-logging accidents. Of the 64 accidents occurring nationwide, Alaska had 15 (23%) of the accidents. Without denominator data (i.e., per heli-logging "turns" or per thousand heli-logging flight hours), which is unavailable at this time, I'm not sure how to interpret this. Can anyone here suggest an explanation for this? Which state conducts the most heli-logging?

Charts J and K demonstrate the differences in external load helicopter accidents by operational phases in which the accidents occurred. When non-logging-related helicopter accidents take place, they most often occur during the landing phase (22%), with the hovering phase coming in second (19%). When we look only at long-line logging helicopters and further sort for geographic variations between Alaska and the rest of the U. S., the differences become striking. Helicopter accidents in the rest of the United States are evenly divided between maneuvering, hovering and landing phases, with descent and other phases coming in smaller portions behind these categories. In Alaska, however, over half occur in the hovering phase. The large discrepancy between Alaska's operational phase statistics and those for the rest of the country should raise many questions: Again, do these data suggest anything about the lack of suitable emergency landing sites? Could this be due to the rough, and often steep terrain of a logging environment, as compared to all other external load operations, and heli-logging in states other than Alaska, where suitable emergency landing sites may be perhaps more plentiful and accessible? If so, then what can be done in the Alaska heli-logging environment to improve the accessibility and suitability of emergency landing sites? Of course, more accidents during the hover phase in heli-logging could be related to more time being spent during that operational phase. And more time in the hover phase could mean shorter turns are also being flown.

As illustrated in Chart L, approximately 90% (59) of the heli-logging accidents were in single-engine helicopters, and almost 10% in twin-engine helicopters. Does this data show that single-engine helicopters are a factor in crashes during heli-logging operations? Or do they indicate that 90% of all heli-logging flight time is conducted with single-engine helicopters?

Again, those of you involved in heli-logging may be able to help us find out if this number is to be expected, or if single-engine helicopters truly represent a risk factor in heli-logging. Surveying helicopter logging operators for numbers of pilots, crew, hours, and flights may help us answer this question.

Charts M, N and O show data of non-logging helicopter accidents versus heli-logging accidents by primary probable cause. According to NTSB, data for all non-logging-related external load accidents (N=156) in the U.S. show that flight crew error accounts for almost half of those accidents (47%), parts and equipment failure account for about 22 %, and maintenance error accounts for 16%. On the other hand, logging helicopter accidents within the 49 states (minus Alaska) were caused primarily by part failures (41%), with flight crew error a distant second (27%), while the Alaska data are strikingly different: we are evenly divided between maintenance error and flight crew error at 40% each, with parts failures at 20%. What does this suggest regarding helicopter maintenance operations in Alaska heli-logging? Several NTSB investigations of logging helicopter crashes in Alaska indicated inadequate maintenance facilities contributing to the probable causes of those accidents.

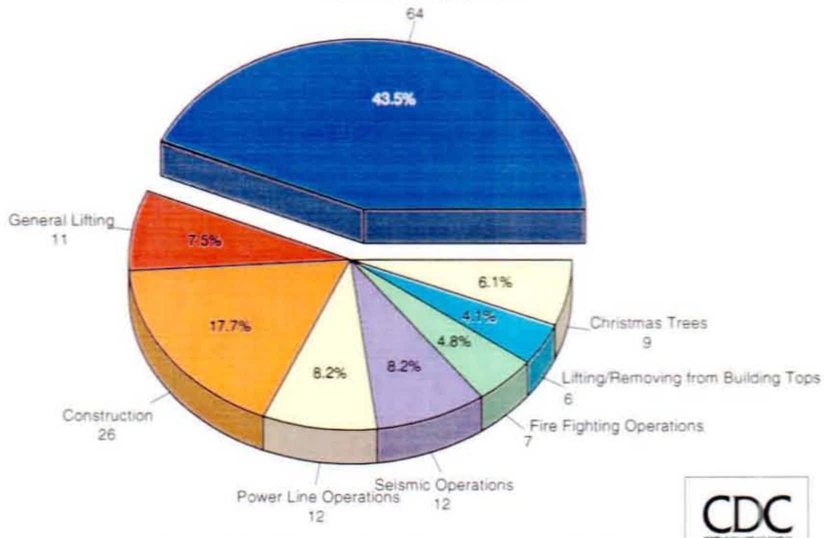
Obviously, NIOSH is still in the initial phases of data analysis of Part 133 (involving helicopter external load operations) helicopter long-line-related crashes, but we feel confident that our research will give us a better idea of what safety issues are involved in this form of transportation. For the near future, NIOSH will be focusing on obtaining denominator data for a better assessment of helicopter logging risks.

In conclusion, consensus recommendations from the Alaska Interagency Working Group for the Prevention of Occupational Injuries offer these findings: To minimize the hazards of helicopter logging, all helicopter logging pilots and ground crews should receive specific training in long-line operation. Each company should follow all manufacturer's recommendations for more frequent helicopter maintenance, because of intensity of use and for limits on maximum allowable loads. Each company should establish and observe appropriate limits on helicopter crew flight time and duty periods.

Chart A

External Load Helicopter Accidents by Purpose of Use Categories, United States, 1980-1994

N= 147 Known Flight Purpose Codes, (73 Flights listed as Unknown/Other)



Source: National Transportation Safety Board, Washington, D.C., 1995

CDC

Chart B

Fatal Crash Rate vs Fatality Rate for Logging Helicopter Crashes (N=62), United States, 1980-1994

14 crashes involving
at least one fatality
of
62 total crashes*

= 23% of crashes fatal

22 total fatalities
of
62 total crashes*

= .35 (mean) fatalities per crash

* Two events have missing data

Source: National Transportation Safety Board, Washington, D.C., 1995

CDC

Chart C

Combined Fatal/Serious Injury Crash Rate vs Fatal/Serious Injury Rate for Logging Helicopter Crashes (N=62), United States, 1980-1994

31 crashes involving at least one fatality or serious non-fatal injury of 62 total crashes* = 50% of crashes involving fatal/serious injury	41 fatal and serious non-fatal injuries from of 62 total crashes* = .66 (mean) fatal and non-fatal injuries per crash

* Note: Two events have missing data

Source: National Transportation Safety Board, Washington, D.C., 1995

CDC

Chart D

Fatal Crash Rate for Non-logging External Load Helicopter Crashes (N=152), United States, 1980-1994

25 crashes involving at least one fatality
of
152 total crashes

= 16% fatality crash rate

CDC

Source: National Transportation Safety Board, Washington, D.C., 1995

Chart E

Combined Fatal/Serious Injury Crash Rate for Non-logging External Load Helicopter Crashes (N=152), United States, 1980-1994

25 crashes involving at least one fatality
and
30 crashes involving at least one serious injury
of
152 total crashes

= 36% fatal/serious injury crash rate

Source: National Transportation Safety Board, Washington, D.C., 1995

CDC

Chart F

Fatal Crash and Fatality Rates for Logging Helicopter Crashes (N=15), Alaska, 1980-1993

Five crashes involving
at least one fatal injury
of
15 total crashes

= 33% of crashes fatal

ALL ACCIDENTS IN ALASKA WERE CRASHES

11 total fatalities
of
15 total crashes

= .73 (mean) fatalities per crash

Source: National Transportation Safety Board, Washington, D.C., 1995

CDC

Chart G

Combined Fatal/Serious Injury Crash Rate for Logging Helicopter Crashes (N=15), Alaska, 1980-1993

Five crashes resulting in at least one fatality and Four crashes resulting in at least one serious non-fatal injury of 15 total crashes

=60% fatal/serious injury crash rate

ALL ACCIDENTS IN ALASKA WERE CRASHES

11 fatal and 11 non-fatal serious injuries (22) of 15 total crashes

=1.47 (mean) fatal and non-fatal serious injuries per crash

Source: National Transportation Safety Board, Washington, D.C., 1995

CDC

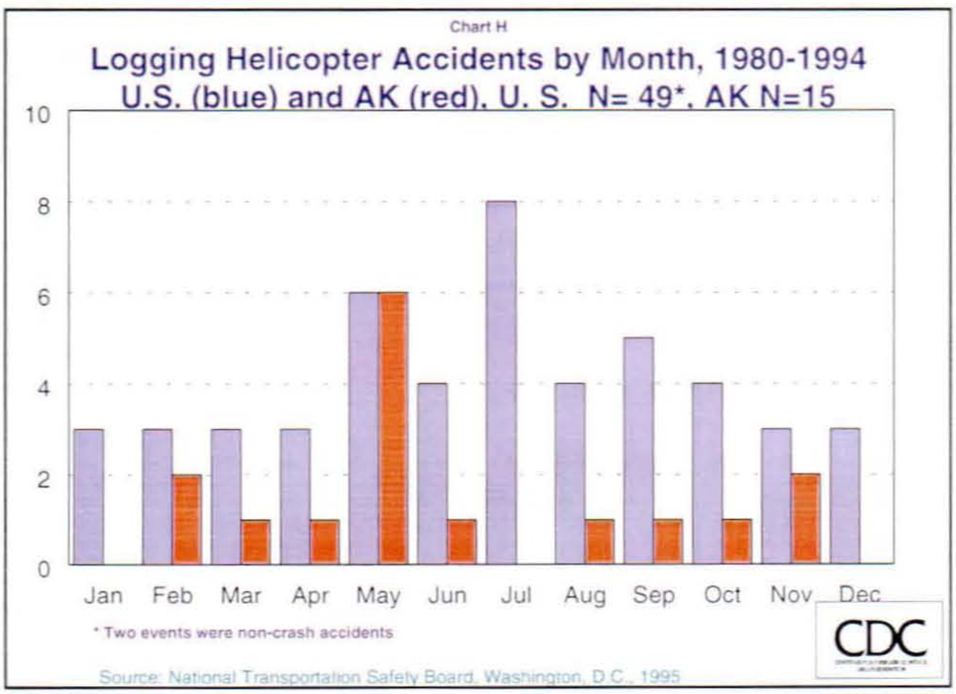


Chart I

Known Long-line Logging Helicopter Accidents by State, All U.S., 1980-1994, N=64**

State	Number	Percent*
Alaska	15	23
Washington	11	17
California	9	14
Oregon	8	13
Idaho	6	9
Alabama	4	6
South Carolina	4	6
Georgia	2	3
Florida	2	3
Montana	2	3
Louisiana	1	2

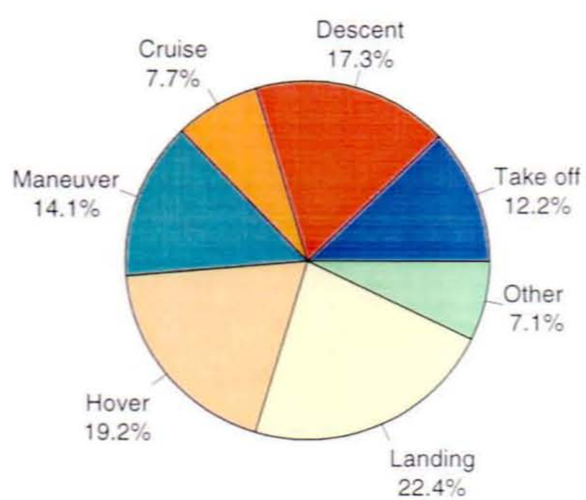
*Percentages rounded to whole numbers

** Two events were non-crash accidents

Source: National Transportation Safety Board, Washington, D.C., 1995

Chart J

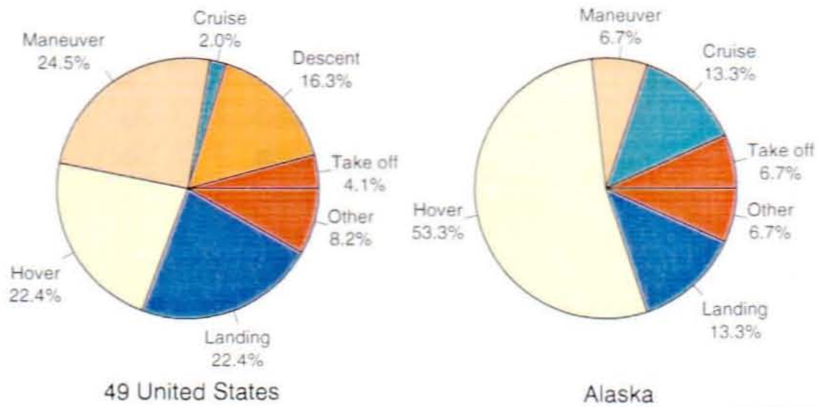
Non-logging, External Load Helicopter Accidents by Operational Phase, United States, 1980-1994, N=156



Source: National Transportation Safety Board, Washington, D.C., 1995

Chart K

Logging Helicopter Accidents by Operation Phase, 49* United States (N=49), and Alaska (N=15) 1980-1994



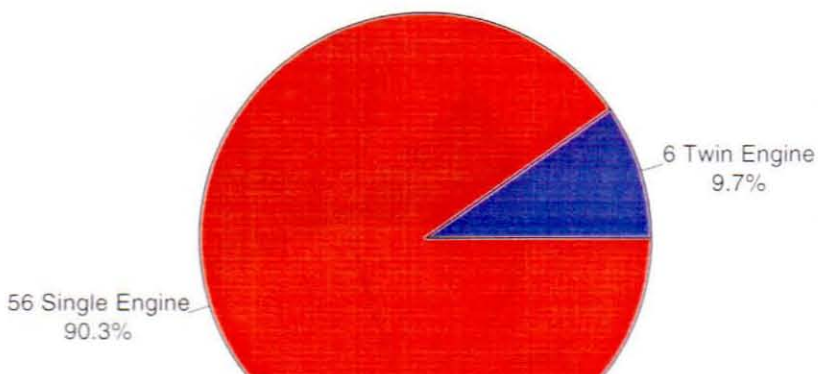
* Two events were non-crash accidents

Source: National Transportation Safety Board, Washington, D.C., 1995

CDC

Chart L

Long-line Logging Helicopter Accidents (N=62*) by Number of Engines, United States, 1980-1994



Source: National Transportation Safety Board, Washington, D.C., 1995

CDC

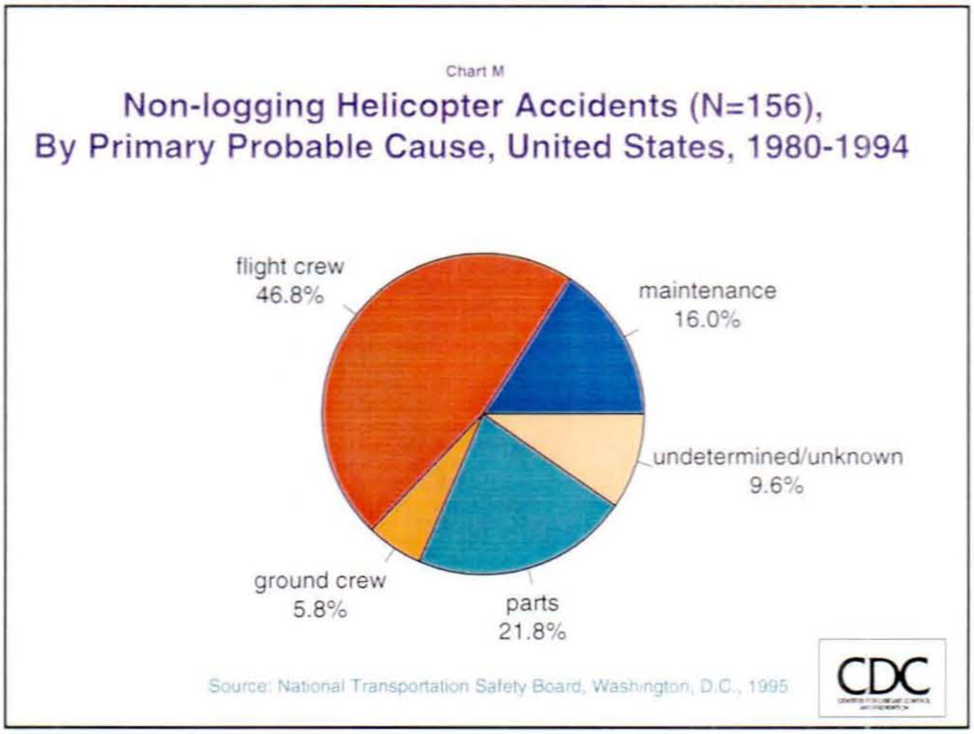


Chart M
Non-logging Helicopter Accidents (N=156),
By Primary Probable Cause, United States, 1980-1994
flight crew
46.8%
maintenance
16.0%
undetermined/unknown
9.6%
ground crew
5.8%
parts
21.8%
Source: National Transportation Safety Board, Washington, D.C., 1995
CDC

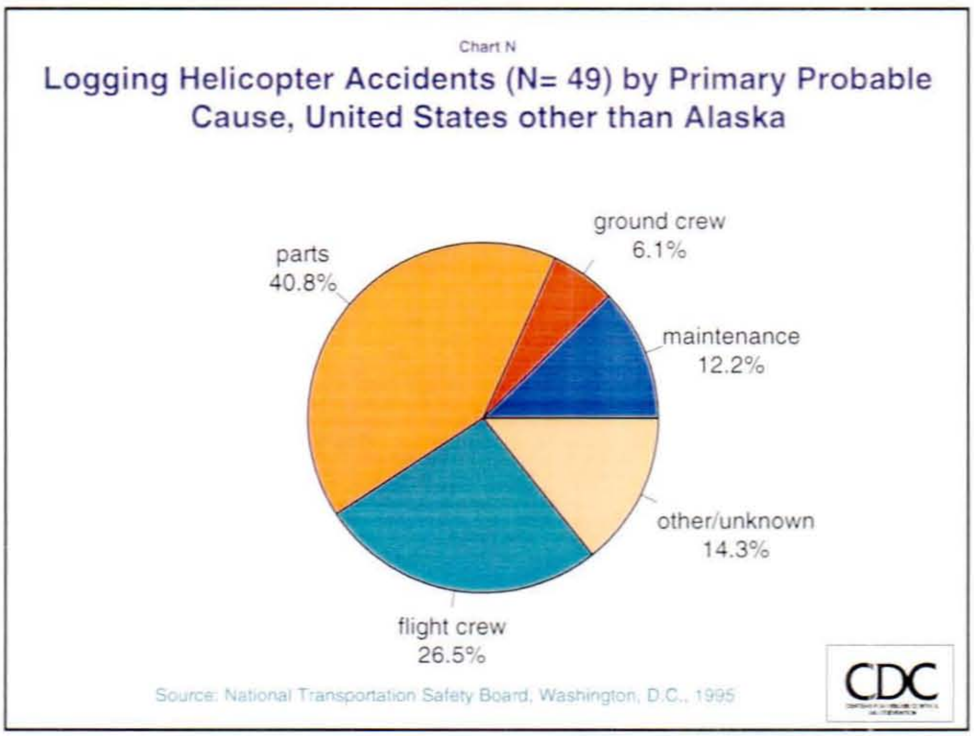
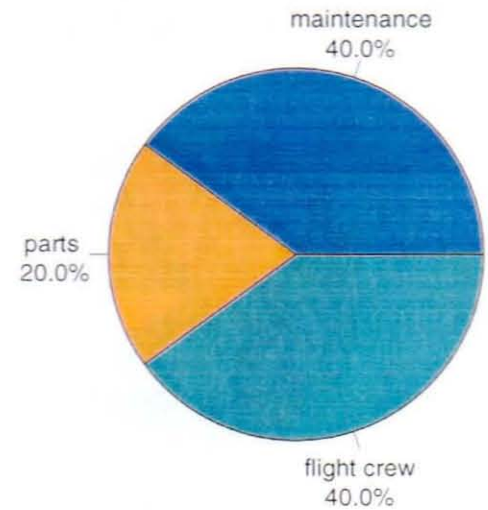


Chart N
Logging Helicopter Accidents (N= 49) by Primary Probable
Cause, United States other than Alaska
parts
40.8%
ground crew
6.1%
maintenance
12.2%
other/unknown
14.3%
flight crew
26.5%
Source: National Transportation Safety Board, Washington, D.C., 1995
CDC

Chart O

Long-line Logging Helicopter Accidents (N=15) by Primary Probable Cause, Alaska Only



NOTE: ALL ALASKA ACCIDENTS WERE CRASHES

Source: National Transportation Safety Board, Washington, D.C., 1995

CDC

QUESTIONS AND ANSWERS

MR. ROY FOX (Bell Helicopter): I can't speak to the exact percentage of logging here. But let me warn you, we see the same thing all around the world. Basically, 85 percent of the fleet out there is single-turbines of all kinds. That means 15 percent, worldwide, would be twin-turbines.

MR. RANDY ERWIN (Erickson Aircrane): You have access to all this data. It might be enlightening to overlay a pie chart of the one that showed 90 percent single-engine accidents over ten of twins, as to how many of the accidents were due to an engine failure. I mean the six accidents that Dr. Conway brought up in the very beginning, only two of them were engine failures. All the rest were pilot error or other malfunctions.

MR. JIM HARPER (Erickson Aircrane): I notice that both yours and Dr. Conway's data bases are incredibly small. I don't know what one can infer from that, but the implication that has been promulgated by NIOSH is that, predicated upon these data bases, we have, I think, been labeled the most dangerous occupation and so on, because especially in '90 - '92, crashes were occurring. Now, I noticed also in the data that in '94 there was nothing. Can one now infer that it's the safest occupation in the world? I guess what I'm saying is, how much veracity do you give to the data that was derived from these bases, A; and B, what do you see as your level of reliability on the data?

DR. GEORGE CONWAY (NIOSH): Without getting into too much of our scientific approach to this, the data that I presented was complete for the entirety of Alaska for the time period covered. However, the smallness of the numbers that you're pointing out is not only in the numerator, not only in the number of events, but also in the denominator, the number of people working in that setting. Both of them, I believe, are complete, and, therefore, an accurate representation, or parameter, for the population at risk during that interval.

Now, we are very pleased that there have not been any additional fatal or serious non-fatal injuries directly in helicopter logging operations. And we're very heartened by that. However, we're also aware that the two companies that had really gotten in trouble aren't in business here anymore, and we're not aware of any restraint, be it economic, political, or regulatory, against weak players entering the field again. So, one of our concerns is making sure that what we develop, or start to develop during these two days, is consensus on what appropriate equipment and what appropriate practices are in this operation to make it very safe.

I don't think I would disagree with any of the observations that you're making, but I would say that as far as the completeness of the information and the smallness in the numbers, these operations are still relatively small in Alaska. However, what is going on has been very, very hazardous. And one of the concerns that we have is making sure that the maximum learning from these events is derived both for use in Alaska, as well as to help other people to avoid these dark months that we had here, in the future and in other settings, because this is a rapidly expanding type of logging, and because the recent Alaska experience may represent the worst case scenario, and the worst case is the right place to look to understand what the hazards are.

Because of the difficulties in maintenance in remote areas, and the problems that can arise in such settings, this may be the best place to be learning about this.

MR. MANWARING: Let me just make one comment. We did contact FAA and obtained a preliminary denominator. I believe they said 1,923 pilots in the U.S. were certificated in Part 133 operations. When you calculate that out over all external load operations, there are very high national and Alaska rates for fatal and serious non-fatal injuries. I think we said that it's something in the magnitude of five percent of the current workforce in lift-load operations are involved in Alaska heli-logging. Although helicopter long-line logging stood out as being particularly hazardous, we want to look at all types of external load operations as well.

MR. FOX: Some years ago, we tried to look at pilot experience, not from the logging aspects, in the Gulf of Mexico where there had been a lot of human error accidents. We started looking at where the pilot accidents were occurring and we thought they were going to be inexperienced people. What we tried is a good technique, that I would suggest to you might be good. First of all, is forget the pilot's total time. Maybe 24,000 hours in Ford Tri-motors. Who cares? What you're interested in is the hours that the pilot has in the make of aircraft in which he is flying. And that, if you've got it, it's great. But, in general, you've got to keep it to at least the type of aircraft. Second is, once you determine that distribution, how many have 100 hours or less, and each 100 hour increment. That curve is worthless unless you know what the average pilot is.

Now, here's the sneaky way. You go look at the pilots that were along for the ride. There was a material failure of some kind that brought him down. So, his skill has nothing to do with the outcome. Now, the distribution of pilots that were along for the ride is the same distribution of all pilots. And that way you can compare the two, put them in the same percentage of hours he has aboard. When we did that, we found there was no difference, other than the first 100 hours there was a difference. But, once we were past that, the problem out there is not skill, it's judgment, poor judgment. It's another way of doing it, because everybody just grabs a number and says, well, look how many inexperienced pilots there are. That may not be the case at all.

MR. MANWARING: Suggesting the possibility of better training, I'd like to clarify a point. When we looked at total model hours for pilots involved in long-line logging accidents, about a third of them appeared to have less than 1000 hours in the helicopter model they were flying.

MR. J. P. JOHNSON (U.S. Forest Service): I think, what I'm hearing so far, is that we're maybe not looking at getting the right answers from some of the data. Let me broaden the data base just a little bit.

In 1994, under contract with the U.S. Forest Service, Department of Interior, and these are accident-free hours, the Type I helicopters, large logging helicopters, flew 11,082.7 hours for us, external load, accident-free. The Type II helicopters, single-engine, multi-engine, primarily external load, probably 80 percent external load, flew 6,926.3 hours for us, accident-free.

MR. MANWARING: In what types of operations?

MR. JOHNSON: In what we call external load; fire fighting, and moving equipment by long-line, which are all external 133 type operations.

In military use of Type I helicopters, we flew 600 hours and we did have an incident with an accident, an incident, with a fatality. The Type II military helicopters flew 1,750 hours accident — incident-free. So, I hope that maybe that broadens what we're looking at. I think the mission, logging and fire fighting, as far as we're concerned, is pretty much interchangeable, maybe broader than what we're looking at, because I get the feeling that we're skewing this a little bit because maybe the answer is not so much single-engine. The problem went away when some other factors went away.

PUBLIC HEALTH APPROACH TO PREVENTING HELICOPTER LOGGING INJURIES

By Gary Bledsoe, Manager, Alaska Occupational Injury Prevention Program, AKDHSS

I'm going to talk about the public health approach to crash investigation so that you can see how it might be similar to traditional approaches, and also some of the differences that we've incorporated from the science of public health. I would like to begin with the definition of several terms. We have used the term epidemiology quite a bit so far, yet I'm not sure everyone here fully understands that term, so I'd like to read a couple of definitions to you.

When we talk about public health, what we mean is the art and science of dealing with the protection and improvement of the community's health. This is a very general definition, so that it includes the control of infectious disease, which is generally considered to be the role of public health . But it also includes prevention of injury and the control of physical, biological, and chemical agents in the environment.

Epidemiology is a sub-specialty of public health that studies the distribution and determinants of health-related events in specific populations. This information is used to control health problems, an activity referred to as applied epidemiology.

Traditionally, epidemiology was applied to infectious disease using the infectious disease triad. There are three sets of factors that enable us to control disease: the host, or the person infected, the infectious agent, the virus or bacterium, and the general environment. Epidemiologists found that if they could control one or all of these factors, they could actually control disease. A famous example from history of this approach is the work of John Snow in 1854 in London. He was able to control an epidemic of cholera without any knowledge of the germ theory of disease or the availability of antibiotics. He did so by using common sense and looking at the available data using the epidemiologic model. Snow plotted cases on a city map as they occurred in relation to city water pumps. He found a particular pump that was implicated. By removing the handle from the pump and preventing its use, Snow was successful in controlling a major epidemic.

Public health researchers have applied this same methodology in the research of injury prevention. The disease triad has been modified into an injury triad with the host as the worker, the agent as an external energy source or an engineering factor, and the environment as the workplace . The first reference I can find related to the public health approach is an article by Hugh DeHaven, of Cornell University. He was a Royal Air Force pilot in World War I who survived an airplane crash. He didn't attribute luck or supernatural causes to his own survival. Rather, he began to look in a scientific way, in terms of engineering and physics, at why he survived this airplane crash and he also used the principles of epidemiology.

In World War II DeHaven authored a landmark article, *Mechanical Analysis of Survival in Falls of 50 to 150 Feet*. He collected data (and analyzed it epidemiologically) about injuries involving civilians who had fallen from various distances, many of them in attempts to commit suicide. DeHaven then applied this information to the design of aircraft, particularly with regard to ergonomic factors (e.g., the placement of controls). DeHaven's use of epidemiology was very important in the evolution of a public health approach to injury control.

Currently we use the Time-Phase Matrix, first described by William Haddon, who, in the 1960s, developed this tool to analyze automobile crashes. Haddon divided the events of an injury incident into the pre-event, event, and post-event phases, and then looked at each of the injury triad components in light of what was occurring at a specific point in time: before, during and after the incident.

I would like to show you how this methodology might be applied to a helicopter incident, using the Hobart Bay crash as an example. I have entered a few of the salient features of the incident into a Haddon's Matrix (Figure 1).

In this case a helicopter was returning loggers to a camp. There was a problem with one of the passengers receiving electrical shocks, apparently due to static electricity being transferred to the helicopter from the main rotor. A 30-foot choker cable was attached to the helicopter to act as an electrical ground. However, the cable was not removed during the flight and the cable became entangled with the tail rotor. The pilot heard a loud bang and attempted autorotation. He overflew the intended landing site and crashed in rough terrain, killing the copilot and five passengers, and seriously injuring himself and four other passengers.

Now, if we can apply Haddon's Matrix to this particular case, causative factors begin to emerge. You may disagree with where I've placed some of these factors, or you may have ones of your own that you're more knowledgeable about, but our motive at this point is simply to analyze this incident using this analytical model.

In the pre-event phase, looking at worker factors, the question of policies and enforcement regarding flying with attached cables is certainly relevant. Did those policies exist? Were they enforced? What were the training policies and requirements for pilots? Why were the passengers not restrained? Did they know the requirement regarding seat belts? When using this matrix you may not know all of the answers, and you may find that some of your ideas are not necessarily valid. Remember that as your research progresses, this table can be refined; it's a tool to help you gain understanding of the incident.

As we examine the pre-event phase, we can also evaluate the energy source and engineering factors. One circumstance that led to the Hobart Bay incident was the inability of the helicopter to land on the ground and pick up the passengers, thereby requiring an electrical ground due to electrostatic charge buildup. The matrix provides information regarding the lack of a safely engineered external grounding system. Perhaps these systems exist, but in an initial analysis, this is a factor to be considered. If there is an actual need, and helicopters commonly experience the problem of static electricity, why isn't an external grounding system used in those situations where the aircraft cannot land and must hover to pick up a load?

As we evaluate the data concerning the pre-event phase, one can find a number of contributing factors. Stumps and uneven terrain at the pickup site made landing impossible. As we have just seen, static electricity can also be considered as an environmental factor.

In evaluating the event phase, certainly you'd want to look at pilot and copilot emergency procedures, unrestrained passengers, and, in terms of the energy source, the attached 30-foot choker cable which is obviously a critical factor. The lack of seat belts for all of the passengers is an environmental factor that was crucial in this incident. The environment at the site event crash was also a contributing factor: rugged terrain, limited landing sites, and the presence of tall trees. Many other factors may be associated with the event phase and can be identified by experienced aerologging workers.

In the post-event phase, the environment is a major factor in Alaska because of isolated rescue sites and poor accessibility to these rescue sites. Thus, severely injured people are more difficult to retrieve and transport to adequate medical facilities.

Haddon's Matrix can be applied as an analytic framework by any crash investigation team. The advantage of this model is that it prevents the tendency to look for a single cause theory for injuries and incidents. This method requires you to look at a broad range of factors that may not always be considered. The matrix helps us to develop a multi-factorial analysis of what caused a particular incident.

HADDON'S MATRIX
Factors

Phases	Worker	Energy Source	Environment
Pre-Event	1. Policies/enforcement regarding flying with attached cables 2. Training policies and requirements	1. Inability to land to pick up passengers 2. Attachment of choker cable for electrical ground 3. Lack of safely engineered external grounding system	1. Stumps and uneven terrain at pick up site 2. Potential of static electricity
Event	1. Pilot/copilot emergency procedures 2. Unrestrained passengers	1. Attached 30' choker cable 2. Lack of seatbelts for all passengers	1. Rugged terrain 2. Limited landing site 3. Presence of tall trees
Post-Event			1. Isolated rescue site 2. Poor accessibility

Figure 1

HELICOPTER LOGGING FROM A PILOT'S PERSPECTIVE

By Mark Lindamood, Chief Pilot, Carson Helicopters

I work with Carson Services, based in Perkasie, Pennsylvania. I operate our Jacksonville office in Jacksonville, Oregon, where I'm in charge of the helicopter logging.

I'm licensed in both the United States and Canada as an air transport pilot with full instrument privileges, and I'm type rated in the Sikorsky S58, 61, and 64. I have 29 years experience and more than 18,000 hours of logging. I've spent the majority of that time in external load work, using vertical reference.

Except for the war, most of my flying has been in large, over 12,500 pound, multi-engine helicopters. In the late 1970s, I started as a logging pilot, flying a Bell 214. I attended the factory school and listened to all the propaganda from Bell Helicopters about the safety of the aircraft. I flew approximately 960 hours in a Bell helicopter when the clutch assembly failed. The engine began overspeeding and automatically shut itself down. We were over tall trees and steep terrain when this occurred and so a hovering autorotation was impossible. I suffered broken bones and spent a year recuperating. I still suffer with back pains today.

The next aircraft the company purchased was another Bell 214 which only lasted about 265 hours. When it crashed, Gary Morden was seriously injured with a broken back. We were, however, very lucky. Bill Fife, Kevin Dahl, Carson Snow, Kurt Zuwalski, Tom Lights, Roland Maxwell, Billy Bliss, Joe Cook, Tim Wiltrout, and many, many more men did not go back to work after their accidents in single-engine aircraft weighing less than 12,500 pounds. These men died from injuries as a result of these crashes, leaving behind grieving widows and fatherless children.

I believe that 90 to 95 percent of all cargo tons of logging weight is flown by large, twin-engine helicopters. These aircraft are mostly Sikorskys and Boeings, safely flying millions and millions of tons every year. Our Sikorsky S61s average 1,000 tons a day, six days a week, for over 2,000 hours each year alone. Columbia Helicopters must do at least ten times that much. Erickson Aircrane, Solar Brothers and Croman Corporation all operate large twin-engine aircraft designed to safely handle heavy external loads.

The small, single-engine aircraft operators (those operating aircraft under 12,500 pounds) which are predominately Bell Helicopters and a few Kaman aircraft move the remaining five or so percent of external logging material. These aircraft were designed for rescue missions, aeromedical evacuation, transportation of personnel, and light internal cargo. The hooks on these aircraft were an afterthought.

When we are logging, we are almost always in very rugged, steep, mountainous terrain, among tall trees. If we weren't, we could use other, less expensive means of harvesting the timber. In logging there are usually very few suitable, safe landing areas where the pilot can land the aircraft in the event of an emergency.

Notice I said "in the event of an emergency" and not "in the unlikely event of an emergency." That's because helicopter logging is very, very hard on the machines, and there will inevitably be times when the pilot must react to mechanical problems. The suitable safe landing area that I spoke of is usually the log landing or the service landing, which is often the only flat piece of clear ground nearby. It is busy, with noisy, heavy equipment, and men scurrying about pulling chokers and operating loud chain saws.

If the pilot is forced to execute an emergency landing to the log landing or service landing, this may not seem to him at the time to be a very suitable landing area. Helicopter logging engines are cycled from flight idle to full speed every minute and a half. Just imagine accelerating your automobile engine from idle to full throttle 320 times a day, six days a week, 52 weeks out of the year. Engines do quit. Clutches fail; inputs fail; fuel pumps stop pumping; accessory drive shafts break; power plants do stop running, and most always at times when the pilot least expects it.

However, if a pilot is flying a twin-engine helicopter, things are a lot easier to handle. He doesn't have to crash into the trees or try desperately to execute an autorotation to the log landing hoping that the loader operator and the ground personnel are able to hear above all the noise and can dive for cover to avoid getting their heads chopped off or seriously injured by flying parts and pieces of the rotating systems of the helicopter as it crashes right in the middle of their work space.

I know this because I've had at least 12 power plant failures. Only one time was there any damage to anything or any people, and that was when I was flying a Bell 214 single-engine helicopter.

Jim Lematta of Columbia Helicopters once told me over the phone that he had a pretty good engine overhaul shop. I told him I thought it was the best engine overhaul shop of its type in North America. He then said that if he were operating single-engine helicopters in a logging environment, he would have lost his whole fleet by now. That made a lot of sense to me.

The large twin-engine helicopters have two pilots rotating back and forth between the pilot in the left seat and the copilot in the right seat. This not only reduces fatigue, but also enables the copilot to monitor the engine temperature and pressure gauges, the warning lights, fuel quantity, and the weight load cell. He can relay to the pilot the actual weight of the load while the pilot is picking it off the ground. The pilot is then able to concentrate on flying the aircraft and watching for trees and ground personnel. The copilot can also keep the tail rotor and main rotor blades on the blind side of the aircraft clear of obstacles, and alert the pilot of any ground personnel who may have inadvertently gotten in the takeoff path of the aircraft's external load. The copilot also keeps a close eye on the power level, and informs the pilot when he's approaching maximum takeoff power. The copilot does this by lightly applying pressure to the collective pitch, or reading out the power instrument, or both.

The small single-engine aircraft usually only have one pilot, and he normally flies all day long. He must divide his attention between the engine temperatures, pressure gauges, power gauges, warning lights, fuel quantity, and the weight cell, as well as watching his load to keep it clear of the obstacles and ground personnel, and his rotor blades out of the trees. While concentrating on these tasks, he very often lifts too much weight and over-grosses the aircraft before he realizes it. If the pilot already has a load flying down the hill, making an airspeed-over-altitude takeoff, he just continues to fly the load to the log landing. It's not long before this dangerous procedure becomes a habit with him and he does it several times a day, day after day.

The large, twin-engine aircraft were designed to carry heavy external loads safely. These helicopters have two engines, two inputs, two servo systems, two electrical systems, two fuel systems, and two pilots. It's very important to remember what I said earlier, that I believe 90% to 95% of all external load weight is safely carried by large, twin-engine aircraft, and the five or so remaining percent by small, single-engine machines.

If you men and women here today of the NTSB, the FAA, and other agencies will review the facts that you already have at your disposal, I'm quite sure that you'll soon realize that five percent of the small, single-engine aircraft are responsible for 95 percent of the serious and fatal injury accidents.

Bell Helicopters' UH-1 series, its 214, Kaman Huskies, and even the new K-MAX Air Truck, are, in my opinion, flying death traps when used in helicopter logging. They are constantly operated inside the shaded side of the height velocity curve, the "dead man's curve", where executing a successful hovering autorotation is not practical even in an optimum environment such as flat, clear ground, let alone steep hillsides and tall trees.

This height-velocity curve is in all the flight manuals. It's an area of flight where continuous operation is not recommended, yet that is exactly where many helicopter logging operations take place. With twin-engine helicopters, the danger from this height-velocity curve is almost completely eliminated. Single-engine helicopters must be prohibited from performing external load work. They simply must be stopped.

In the mid-1930s the government took a bold step. It wasn't afraid to act. It cared more about human life than about what a few aircraft manufacturers said. They enacted a rule that all scheduled passenger service would have to have at least two engines. Parks and Fairchild and others thought the government had gone way too far, that they were way too restrictive. But look at air travel today, all over the world. It's safe and reliable because of the concern and guts that it took, at the time, for a few people in government to enact a rule that they knew would save lives.

They were, perhaps, in a meeting much like the one that we are attending this week. There will be those today who will cry that increased regulatory oversight is going to put them out of business. Well, let me tell you something. They'll be out of business before long anyway. No one I know who operates single-engine helicopters for the purpose of aerial logging ever lasts very long. Sooner or later, after killing a few pilots and wrecking a number of helicopters, they all go out of business.

The problem is that the owners and managers are usually not the pilots who are flying the aircraft. When one crashes, their insurance covers their losses. However, no amount of insurance that I know of can cover the loss of that father or husband who was killed trying to make a living doing the thing that he loved most. If these were Sears table saws, there wouldn't be any more home woodworking projects. If these machines were Singer sewing machines, there wouldn't be any more homemade dresses.

The U.S. Coast Guard replaced its old Sikorsky Cyclops with an S62 multi-engine Dalphine helicopter. The Army replaced its Huey with a twin-engine Sikorsky helicopter. The Air Force and Marines operate multi-engine helicopters because they realize the importance of redundancy while operating in a hostile environment. All helicopter logging takes place in a hostile environment.

I ask, as an experienced helicopter external load pilot, if there are to be any regulations to be written as a result of these meetings, that they include one that prohibits the use of single-engine helicopters for the purpose of conducting external load operations. There are enough deaths already caused by single-engine aircraft to warrant a regulation that states that all external load operations shall be conducted with multi-engine helicopters...period.

You ladies and gentlemen have the wherewithal and the responsibility to safeguard these flight crews and ground personnel, and to keep them out of harm's way. All you have to do is get one regulation submitted and passed, and with the stroke of a pen we can almost completely eliminate these unnecessary injuries and fatalities.

Yesterday on the way up here, I talked with an engine man from Kaman. I said, "You know, as an engine man, you should be happy about such a regulation. You should ask for four engines on a machine, and you can make more money." As a representative of a helicopter company that manufactures single-engine helicopters for logging, this gentleman replies, "There's a financial penalty for having two engines." Well, what's the financial penalty? You know if you've got two engines it's safe. You know you can get out of that "dead man's curve". Believe me, I've flown back to the service landing many, many times and landed with one engine. It's not always the engine that quits, it's the input, or something else that fails. That second engine will get you back. The financial penalty seems a cheap price to pay if we're going to save some lives and save some money on liability insurance and workmen's comp.

QUESTIONS AND ANSWERS

MR. ROY FOX (Bell Helicopter): I certainly didn't come here to debate the single versus twin issue. That certainly was not my intent of coming here. Mine was to talk about the overall helicopter industry and what indications we're seeing in the overall logging area. But, since Mr. Lindamood has brought up a very strong point about single-engines, I just want to caution you, that although I agree with some of the things he says , you must remember that there are more parts than just the engine. There are some places where a twin-engine is the best choice for a mission, and I agree with that. There are other places where it may not be the best. It just depends upon the mission and on the environment. You must remember, there are a lot of parts on that aircraft that are not engine-related. I do like your idea of a second pilot though. I do totally agree with that portion.

When our company looked at the risk per occupant hour, the single-turbines and twin-turbines were exactly the same. The risk per 100,000 occupant hours of someone being seriously injured or killed was the same for any kind of material failure.

I'm just saying there are a lot of issues here that may affect aircraft safety. It's not just a matter of how many engines we're going to stick on them.

MR. LINDAMOOD: The database that you're talking about, of twin-engine versus multi-engine, is over the whole spectrum of helicopter use. All we need to look at here is external load work. Granted, the 206 is a wonderful aircraft for flying people back and forth, but when you start hauling repetitive external loads, something is going to fail. If you've got two engines, you've got a backup. Industry officials, of all people, should be wanting that redundancy, because you spend a lot of time in court and a lot of money on out-of-court settlements, over this same problem.

MR. FOX: Yes, we do spend time in court, but for many reasons. In fact it's rare we're in court over the number of engines, but we spend a lot of time on other things.

The industry is concerned about the safety issues that you've brought up. ICONX 6 is trying to mandate single-engines basically be prohibited from flying over congested areas, meaning cities, recreational areas, and other populated areas. That proposition, basically, may be a kiss of death for the helicopter industry. Now, for the short term, manufacturers would like this proposition, because you can sell twins, and there's a whole lot more money in twins than there is in singles. But, when forming a helicopter industry, you've got to start out in the smaller aircraft and work your way up to the larger ones.

MR. LINDAMOOD: I'm not just talking about the two out of the six total crashes that happened up here in Alaska last year. I'm talking about 20 years of data. I'm talking about putting a long overcoat on a lot of guys after the engine failed, the fuel pump failed, the inputs failed. When you've got an input failure on a Sikorsky S61, the engine quits on that side, so you go back, you land, you take it apart, you put it back together, and you're logging the next day.

MR. FOX: Furthermore, I object to the use of the term "deadman's curve". It's not a "deadman's curve", it's a height-velocity curve, period. The terms that are in there by all manufacturers is, avoid this region. That's there for a purpose. If you get over that line, it doesn't mean you're dead. It means that you are likely to bend the machine in an autorotation. Bend it, not hurt yourself.

This ties back to the twin-engine. The twin-engine height-velocity curve is smaller, but it's still there. And basically with the twin-engine, you just have power en route to the ground. So, that's not necessarily a cure. The reason people go with single-engine aircraft has to do with its being more effective to use one big engine if you're just pulling loads. Now, when you get to extremely large aircraft, then you go with the twin-engines, because it's a matter of getting an engine that will fit the design. So, I think you ought to ignore the single versus twin issue.

MR. LINDAMOOD: There is a "dead man's curve", you guys that fly know that.

MR. DALE HOKE (Aerial Crane Systems, Inc.): My only point is about this height-velocity curve business. Mark Lindamood and I have spent many hours in the cockpit together beating each other over the head, because most logging helicopters of the multi-engine variety are operated at a very, very low empty weight. So, at most reasonable altitudes there is no height- velocity curve. If you lose a power plant, you can sit there and hover on the good one.

MR. LINDAMOOD: You can climb out.

MR. HOKE: Or climb out, and that's a very comforting thought. This is not necessarily true of some passenger carrying twins, because they've got seats and other equipment in them, but at the logging weight of a multi-engine helicopter, you can dump the log and you're in fat city.

MR. DOUG HERLIHY (former NTSB crash investigator): I didn't want to get in between the adversaries of single and versus multi-engine. You've got great points on the multi-engine issues. But we can't overlook the fact that there are some human factors in here other than just the machines that have failed.

MR. LINDAMOOD: It goes back to what I was saying about small, single-engine helicopters, those aircraft under 12,500 pounds. In the not too distant future I believe there's going to be a whole bunch of 204s and 205s released from the military for surplus. I want to see surplus equipment on the market. It has to be. We need parts and pieces. But, when you get small, single-engine operators who can pick up an aircraft for $50,000 or $100,000 and instantly become helicopter logging operators, our insurance rates go up. These accidents really do affect us. Look at the penalty on that extra power plant, look at the penalty that raises two or three percent of insurance on your hull insurance . These things far outweigh the cost of having another engine. We move most all the logs with large, twin-engine helicopters. When single-engine people come in, poof, the accident rate goes to hell.

MR. MIKE ABDALMASEH (Kaman Aerospace): I'm the guy that Mr. Lindamood was talking to on the airplane yesterday. I'd just like to clarify my part of the conversation. We believe that the Kaman K-MAX is designed for the repetitive lift scenario. The hook wasn't an afterthought.

MR. LINDAMOOD: No. I agree with that. I said on some of them, the manufacturers appear to have regarded the hook as an afterthought.

MR. ABDALMASEH: Kaman went through extensive testing to verify that. I have to take exception to single-engines being called a flying death trap also, and I'd like to think that everybody else out there would too.

MR. LINDAMOOD: I said that this was my opinion.

MR. ABDALMASEH: I understand, but I just wanted to put that in.

MR. LINDAMOOD: Thank you. The engine on your aircraft, as you said yesterday, was D rated. It still hit its 100 and some percent of N-1, but the temperature was lower to give you less horsepower, right? So you're still speeding it up and slowing it down; speeding it up and slowing it down. We don't have enough time on this aircraft. We're going to field test this aircraft to see if it's going to kill anybody. That's an issue that I am concerned about. I know you've got some time on your craft that will allow for study. But I'm talking millions of hours of data that we've got on twins.

MR. ABDALMASEH: Well, again, I have to take exception. I don't agree that all the twins were designed for the repetitive lift cycle. They were certainly designed for heavy lift, but not the repetitive, with the load on, load off. You're talking about a different load scenario there, and I don't necessarily agree with that either. But again, I don't want this to be a debate about it.

MR. LINDAMOOD: Well, aside from the single-engine logging, we have to be concerned about the single pilot in the aircraft. This man is experiencing information overload. He's got to sit in there and go through all his tasks; he's in a constant running conversation on the radio with all the people. "I've got a three-logger up the hill with two stringers running uphill; two stringers downhill that weigh 8,500 pounds." "Here I am, 12 o'clock, 12 o'clock." "Here, you're flying over me." He's listening to all that, plus he's doing all his work inside the cockpit and outside the cockpit so this guy's bombarded with stuff.

MR. ABDALMASEH: Excuse me, if I could just comment on that also. I think that falls into the human factors rather than the helicopter design, and I think that the K-MAX was designed for that mission.

MR. LINDAMOOD: I just wondered who is the weapons officer in a K-MAX? Who's handling those radios? I hope that everybody really understands what I'm trying to say and gets some information back to the people who make these decisions. It would really impact the accident rate.

ALTERNATIVE AEROLOGGING TECHNIQUES

By Dale Hoke, Owner, Aerial Crane Systems, Inc.

After four years as a pilot in Army helicopters, I worked in the heavy helicopter industry for over 18 years. I grew up in it; started logging on logging sale number one, using helicopter number one with Wes Lematta in the late 1960s. I have piloted just about every make of major heavy lift helicopters in the country. About eight years ago, I started developing a system to replace the use of long-line helicopters and to address the issues of safety and costs.

The company I represent, Aerial Crane Systems, Inc., offers an alternative to helicopter lifting. The alternative system promises to benefit the forest products industry. The aerial crane system is constructed with an aerostat tethered to light weight lines controlled by four winches.

Our basic concept was an aerostat of sufficient lift attached to a payload. If the aerostat and payload weight are balanced exactly, the payload can be held with your hand and walked wherever you want to go. We took the concept, used winches to move it, enough aerostat to lift payload, minimum tension on the strings, and enough horsepower in the winches to bring it down to drop off the payload. By using high tech lines, we can gain distances to half a mile, maybe as much as a mile, and do it at significantly less cost than by using a helicopter, without the rotor wash, dust, and vibration that cause helicopter pilots to go gray rapidly.

We constructed two prototypes. We micro-scaled it and found it was so easy, we couldn't help but wonder why someone hadn't built it before we did. We shifted to a little larger scale and modeled it again. We learned that as we got bigger, things got better. The good parts of the system became better, and the troublesome parts didn't get any worse.

We reached a point where we needed to construct the system on a significant scale, because people weren't going to get excited about a system hauling logs that only weighed a few ounces. In the spring of 1992, I obtained funding to build an 800-pound prototype. The 800-pound limit was partially determined by the size of an available used aerostat; the aerostat is one of the significant costs of this system. The 800-pound size also compared favorably with the early Jet Rangers which also weighed around 800 pounds and with which I was very familiar. I knew what the Ranger lifted, what it cost to operate, and what it cost to buy. Thus, in the Ranger, we had a good comparison to our aerostat.

We finished the system, tested it, and had it up and running (inflated the aerostat and had all the winches deployed) by the 26th of June, just six months and two weeks after the start of cutting metal. The history of lighter-than-air (LTA) vehicles is replete with projects which suffered because the systems people involved worried so much about getting the machine running, they didn't learn how to handle it. Systems like the cyclo-crane came to an end because no one could control them in any kind of weather. They were huge and unwieldy. The forces of Mother Nature are immense, and in the woods, there are no 100-acre parking lots in which to moor and park these LTAs.

Not only did we want to make the system work, but we wanted to be sure we totally understood how to handle it, how to take care of it, and how to deploy it in the woods where ground access such as a convenient road system is unavailable. We inflated on the 26th of June with a very basic analog control system. The third day up a thunderstorm hammered us but we survived -- just barely. Then we commenced with actual operation, going from point A to point B, which, in just a few minutes, got very boring because it was so easy. We found we could even put an inexperienced operator at the controls of the system, and in a matter of seconds, he would hit accuracies with 200-foot lines, which would take a helicopter pilot weeks, months, and sometimes years to attain.

One of the reasons for this ease of operation was the point in space, defined by the common point connected to the four winches by the control lines. The large and quite rigid triangles formed by this arrangement hold the point in space as stable as a line on a large land crane would, regardless of balloon oscillations. While the balloon moves around in the wind, these movements are not transmitted down through the long-line. If your accelerations and decelerations are ramped as a function of long-line length, which is what a helicopter pilot does unconsciously to dampen out oscillations, this point in space -- this long-line hook assembly -- is rock steady; it just stays there like it's nailed in concrete. This was a significant confirmation of the micro-model work.

We learned that establishing some pretty firm tension control limits, such as minimum and maximum tension on the torque of the winches, we couldn't overload the system. If you hook onto something that's too heavy and try to ascend with it, which is lengthening all these lines, they go down to their minimum tension limit and nothing happens. You cannot over-torque it, you cannot over-extend it, and you can't tip it over. These were gratifying revelations; we were pleased to know about the ease of doing these operations, especially from the standpoints of safety and cost control.

On the second operational flight, the confidence factor was so high after just a few minutes that my daughter, who doesn't like heights or airplanes, went for a ride. As we operated the system again and again, trimming the flight control system and developing better rules, it became boring to operate the machine.

We kept the aerostat inflated 114 days. Our operating costs were about a quarter of that of an equivalent-sized helicopter. We had no night operating restrictions. Fog didn't bother us. We learned to move the aerostat by hand, grab a winch, and transport the system over inhospitable terrain, where there are no roads to the deployment sites. We even worked out a procedure for fueling and maintaining the system at remote sites. We spent most of our time learning how to manage the detail procedures, because the details have killed other LTA projects. This concept has been made possible by the recent advances in material and control technology, much of it from the military and NASA. It means we have the capability to build this system with off-the-shelf equipment in a manner which wasn't possible just a few years ago.

QUESTIONS AND ANSWERS

MR. RANDY ERWIN (Erickson Aircrane): Is this controlled from a gondola, or is it from the ground?

MR. HOKE: Wherever you like. All of the control stations, equipment deck, and winches are electronically linked, whether it's hard cable or RF data link, which is also linked to the control van, so it really doesn't matter.

And, as a sideline to that, you can have multiple control stations. The next step is to get this data stream into a communications network, so you actually can monitor and operate this thing from anyplace in the world. It's got eyes and enough intelligence to know where it is at and where the operator wants it to go.

MR. ERWIN: Wind is not a problem?

MR. HOKE: Certainly wind's a problem. However, if you'll go back through the Forest Service's early balloon logging experiments, the experience of the "Flying Scotsman," and the people who have had large aerostats in the field for extended periods of time, wind is not operationally a problem, any more than it is for a helicopter. When it's too windy, you quit and go do something else. But there usually is enough calm and low wind conditions in most places of the world, enough revenue time that's within your weather limits, that weather is just a minor inconvenience. This is not a good generic system. This is a very, very good site-specific system. In other words, the system would not be the same if it was used on the west side of the Cascades or the Southeast Alaska coast. Two different systems would be used, because you've got different weather parameters to deal with. If you're going to the high-wind environment, the Queen Charlotte Islands for example, then you are going to need a streamlined aerostat, which raises the cost, but the basic concept stays the same.

UNIDENTIFIED VOICE: Does the system require any certification?

MR. HOKE: Not as you know it from the aircraft industry. It's an unmanned vehicle. It comes under the general rules that big cranes come under. We think of it as a big crane with 2,000 foot of reach. We don't think of it as an aircraft. Under current rules it does not have to be certified, and we would have no need to certify it.

MR. MARK LINDAMOOD (Carson Helicopters): How does the system work in snow and heavy ice?

MR. HOKE: The system is bedded down. It's parked.

MR. LINDAMOOD: Bed it down at night, but if it snows a little and freezes?

MR. HOKE: For normal operations, when you're just getting through to the next day, and you're not running a 24-hour shift, the long-line is hooked to a deadman and the control strings are unloaded; it just sits there.

MR. LINDAMOOD: What about the safety aspect of it? If you've got a real light load, you could sit in the gondola and run it, but can the operator see the man hooking up the turn? What about if it's a light load, smashing the guy in the turn with an updraft of the wind?

MR. HOKE: This system, dynamically, is backwards from a helicopter. It takes the least amount of power to operate when it's loaded. It takes the most amount of power to operate when it's empty, because it has to pull the system down against the full lift of the aerostat.

Therefore, when it's in the hook-up mode, there has to be high tension on all the lines. So this place is locked and it doesn't move. The hook is the most stable thing you've ever seen, comparatively speaking. Wind oscillations which move the system around don't transmit down to the hooker. Also, the whole system has a navigation system built into it. You can go anyplace on the sale within 30 centimeters of accuracy without hand flying it.

MR. LINDAMOOD: If it's a light load and the guy is in the middle of an eight log turn and he's hooking it up, is there a possibility of one of the lines coming loose, or the operator doing something that could move it since he can't watch the guy on the ground, like a helicopter pilot can?

MR. HOKE: This operator is going to be able to see right down this line. He's watching the operation on a monitor. You're assuming there is a hooker, and I'm not so sure that with this system we would do that. There's other methodologies we can use.

UNIDENTIFIED VOICE: You were talking a quarter of the cost. Can you give us some kind of production figures?

MR. HOKE: I can give you what I feel we can do, which is about the same production as a helicopter or maybe a little bit less. We won't get production per hour to the equivalent size helicopter, because we can't physically go through the air that fast. This system starts going dynamically unstable, in this size aerostat, somewhere around 30 to 35 miles an hour, so about 2000 to 2500 feet a minute is about the best you're going to do. We're going to operate longer hours, and if we want to, we can operate at night.

UNIDENTIFIED VOICE: Is this the same concept they tried in the early 1970s?

MR. HOKE: No, it's totally different. The conventional balloon logging to date, unless there's somebody that's done something I don't know of, has been hooking a balloon to a standard wire carriage to a standard wire system. They can't lift the whole wire off the ground because it's too heavy, so the wire's in the air as the balloon goes by. It then lays back on the ground with all the associated hazards they go through. So their production is quite slow. They have to set up and move like any other wire setup has to do, whereas our system is fully three dimensional.

We imagine we can cover half mile chunks of real estate with a 9 to 10,000 pound system. Again, depending on the topography and the ridge lines and other considerations, the system must be set up to use all those factors to its advantage. We don't see any technical problems there.

There are ways to do this with central power plants. We've gone to four power plants, one on each winch. One of the reasons we went to the four-wire system is not necessarily due to the increased coverage you get from a four-wire system versus a three-wire system, but primarily because if we lose one of the winches we've still got control of the aerostat. We can still get it down, hold it, and control it. It's not a catastrophic accident. We tested that scenario with the model. It was one of the last tests because it was hazardous. We had the machine winch down tight with one line taking all the tension when it broke, and away she went. But it did exactly what it was supposed to do; the other winches detected the over tension and they spooled out line until it was under control and got it slowed down. It was a non-event.

In the forest products industry, on tough ground, on the shorter sides, this system is a viable alternative to helicopters. There are some things that helicopters do better, but some things the aerostat will do better. Our system can make a significant impact on woods safety, because of its precision, and the direct control the operator has. The hooker in the bush can operate the system. He can have a small control station to give commands to do whatever needs to be done such as giving a stop command to place something precisely, or drift it five feet up the hill.

UNIDENTIFIED VOICE: What's the cost of the system?

MR. HOKE: We feel we can get a bare bones system to a logging job, for about $125 to $150 per pound of payload, or, roughly, a third the cost of equivalent size helicopter. Helium's getting very economical. It's about to come off the world reserve list. That's going to release a tremendous stockpile.

UNIDENTIFIED VOICE: What's the mobilization and demobilization time for the whole system?

MR. HOKE: Mob and demobbing is, to a large degree, like the helicopter or any other setup, in that you know how much preparatory work you have to do. At the winch sites, for example, if the anchors are installed, it can be something as simple as putting a padded choker around a big tree stump, or it can be something as complicated as drilling and putting in a rock anchor. The anchor technology comes out of the power line industry. It's well proven, and is a relatively minor item. If that preparatory work is done, such as building helicopter landings and those things before you get there, you should be able to deliver the system, set it up, and be operational in a matter of a few hours, depending on the topography and accessibility, how many winches you have to fly, and how many you can drive out. We have designed the system where we can leapfrog it across country with no roads. That doesn't do you much good, because you've still got to get the product out of there, but we took a serious look at that procedure for places such as Panama. People want to be able to look at spots in the jungle without leaving any footprints. We spent considerable time and effort on this mobilization and demobilization process. We sized components to go on standard highway trucks. Aerostats can be moved inflated, and don't have to be deflated, within reasonable distances. One of the purposes of the aerial heavy lift system is to work in a particular drainage or area of the country, and be able to stay for long periods of time.

HELICOPTER LOGGING SAFETY: MANUFACTURER'S CONCERNS

By Roy Fox, Product Safety Chief, Bell Helicopter Textron, Inc.

The helicopter manufacturer generally does not hear from operators of his aircraft except when there are problems. In the safety world, this may be during an accident investigation. Thus we see a variety of operators. As a general trend, those operators with good safety records tend to own their aircraft, operate and maintain them properly, use approved parts, and ensure adequate rest for their employees. Conversely, some of those operators with poor safety records tend to be those who exceed operating parameters, use salvaged parts and surplus parts, and fly in bad weather.

Why do military surplus helicopters have a poor safety record? These aircraft tend to be cheaply maintained and attract surplus parts, bogus parts, and salvaged parts, and are doing low profit jobs. A very cheap operation will tend to use overworked and under-qualified pilots. Although some operators of military surplus helicopters do a good job, many operators do not. Abusive use of the aircraft beyond what it was designed to do safely is a major factor. For example, the accident rates per 100,000 hours during the period of 1986-1992 for military surplus UH-1 aircraft is high compared to civil aircraft (Figure 1).

The 10-place military surplus UH-1 closest look-alike is the civil turbine-powered Model 204B. The worldwide accident rate per 100,000 hours for the UH-1 military surplus helicopter in civil use is over two times higher than the civil certificated Model 204B (Figure 2). Some of these aircraft called 204B are counterfeits introduced by putting a real 204B aircraft data plate on a military helicopter.

Accident causes are different in external load/logging missions as compared to other types of operations. Abusive use during external load/logging causes part failures. This is related to subjecting the aircraft systems to conditions for which they are not designed. For example, for Bell turbine helicopters (civil and military surplus) in worldwide use for all missions, the Bell parts failures (e.g., parts other than engine) account for 5.6% of the accident causes (Figure 3). For the Bell turbine helicopters used in external load/logging, 17.3% of the accidents are due to Bell parts failing. This large increase is due to abusive overloading in operation, improper parts, and improper maintenance.

Each model of helicopter is initially designed to a mission profile that includes a varying percentage of time spent in each of the flight phases. In some flight phases some components are higher loaded than in others. For example, the tail rotor and its drive train are very lightly loaded while in cruise flight, whereas the tail rotor is providing maximum thrust at an out-of-ground hover. In addition, the helicopter components are also designed to a maximum number of high torque events per flight hour. All of this results in the retirement lives and overhaul schedules of helicopter components. Helicopters operating outside of these design limits have generated part failures. Logging with helicopters can be putting much higher stress on the parts than you realize. A recent development is to determine the damaging flight events and to better calculate when a part needs to be removed and destroyed to prevent in-flight failure. This latest system is the Retirement Index Number (RIN). A RIN basically counts the number of damaging torque events in a cumulative manner. When that part reaches its RIN value, that part is to be immediately removed and destroyed. The RIN also allows an authorized part to be used on several models where the stresses are different in each model. For example, the 204-011-450-105 main rotor mast has a total RIN of 240,000. This mast can be installed in the 204B, 205A1, and 212 with a fatigue life different in each model. While the mast is in a 204B, each takeoff counts as one RIN and each logging lift counts as two RINs. The same mast installed in a 205A1 would count each takeoff as two RINs and each logging lift as four RINs. Similarly, the same mast in the 212 would count each takeoff as four RINs and each logging lift as eight RINs.

In January 1989, Bell sent a letter to the FAA alerting it that the military surplus aircraft were designed to a different spectrum than repeated heavy lift use. Thus the original qualification data is of no value in quantifying the cumulative damage for repeated heavy lift to allow definition of suitable retirement schedules and maintenance practices. NTSB Safety Recommendations A-92-125 and A-92-126 acknowledged this situation by noting that UH-1 was produced to meet military specifications as a utility vehicle. Accordingly, Bell's recommended component overhaul and retirement schedules were based on the UH-1s primary use as a utility helicopter.

The risk to a helicopter is the frequency of accidents per 100,000 flight hours which is commonly referred to as accident rate. This is not the risk to the occupants on board. The Risk of Serious Injury (RSI) is the individual occupant's risk of a fatal or major injury per occupant hour of exposure. It is essentially the likelihood of an accident times the likelihood of a serious (major or fatal) injury. It is calculated by:

$$RSI = \frac{\text{Accidents}}{\text{Flight Hours}} \times \frac{\text{Number Seriously Injured}}{\text{Number of Occupants Onboard}}$$

Considering U.S. registered helicopters for 1986 through 1992 from NTSB/FAA data, the Risk of Serious Injury per 100,000 occupant hours for an occupant in the 204/UH-1 surplus helicopter was 9.48 as compared to 4.18 in a 205A1 and 1.13 in a 206. An individual's risk is significantly higher in the military surplus helicopters being used in logging/external load operations for which they were not designed.

The legendary Phoenix bird rose from the ashes to fly again and again. Phoenix helicopters can too! The aircraft data plate rises from ashes of a destroyed helicopter to fly again. Such aircraft are counterfeits and are not the original aircraft that met the original certification. Counterfeit aircraft are those which have been illegally converted from military surplus or built up from salvaged and spare parts and are being passed off as genuine commercial aircraft. Such aircraft are disproportionately more likely to be involved in accidents. These aircraft do not meet commercial certification requirements. Because of their low cost, they are magnets for salvaged, surplus, and bogus parts. Low cost also attracts poor maintenance. If these aircraft carry people, they will be a serious competitive threat to anyone with a civil certificated helicopter.

The problem will worsen. The U.S. Army is in the process of surplusing several thousand turbine-powered military helicopters. These military aircraft and parts present special problems. The military procures many parts from non-Bell sources which have historically not been required to meet the Bell quality specifications. The military sets the fatigue lives of components which may be different from those Bell sets on the same part in commercial service, because it operates and maintains them in a different manner and in a different operational environment. Military maintenance histories are rarely available with surplus parts and may not be useful if available. The only certainty with military surplus parts is that they do not have the same predictability as commercial parts.

How can you reduce your risk? To reduce the aircraft risk, you should use aircraft and OEM parts that were designed for your environment. Do not use military surplus aircraft or military surplus parts. You should religiously follow the manufacturer's maintenance and operating requirements. Always observe appropriate rest for crew and maintenance personnel. DO NOT USE ABUSIVE OPERATIONAL TECHNIQUES SUCH AS SNATCHING A LOAD OFF THE GROUND. NEVER EXCEED THE EXTERNAL LOAD LIMIT.

How can you reduce your risk of injury? The pilot should always use a shoulder harness with an inertia reel during flight operations. You can still lean to the side to observe the load. In an emergency, immediately sit straight up with your shoulders against the seat back. The inertia reel will take up all of the shoulder harness slack. This use of a shoulder harness increases your non-injury tolerance in a vertical crash by a factor of six times. The shoulder harness will also reduce the amount of upper body flailing in an emergency which should allow the pilot to control the aircraft and possibly avoid a injurious impact. Use the Energy Attenuating Crew Seat (Kit P/N 412-706-001-111) in a 212 to keep spinal crash loads tolerable without injury.

The good news is that for public service aircraft operators, Bell will still provide product support engineering on a par with operators of commercial aircraft. If you are a commercial operator of a military surplus helicopter, you should look first to your Type Certificate holder for repairs, continuing airworthiness support, service bulletins, and manuals. On military surplus helicopters manufactured by Bell, Bell will provide some limited support on a fee paid basis. Bell and other entities can provide maintenance training on UH-1 and OH-58 aircraft.

KEEP IN MIND THAT FORCING AN AIRCRAFT TO OPERATE BEYOND WHAT IT WAS DESIGNED TO DO WILL HAVE SERIOUS SAFETY CONSEQUENCES.

Figure 1. Civil Aviation Aircraft Safety
NTSB/FAA 1986 - 1992

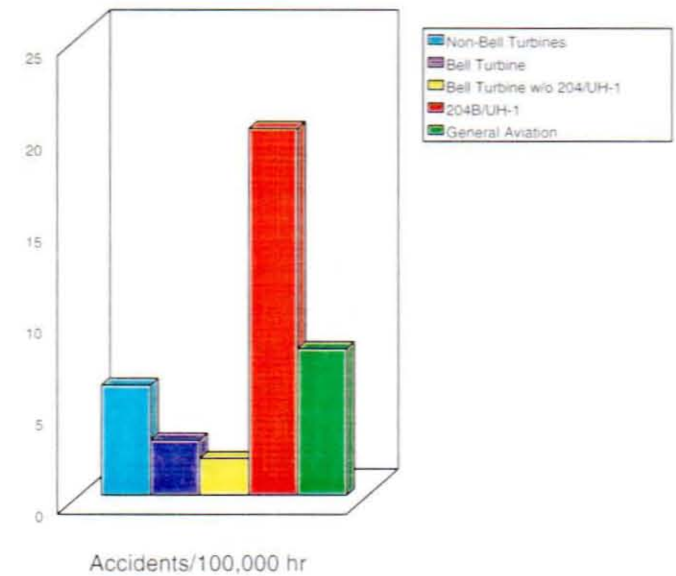


Figure 2. Surplus vs Civil 240B Safety

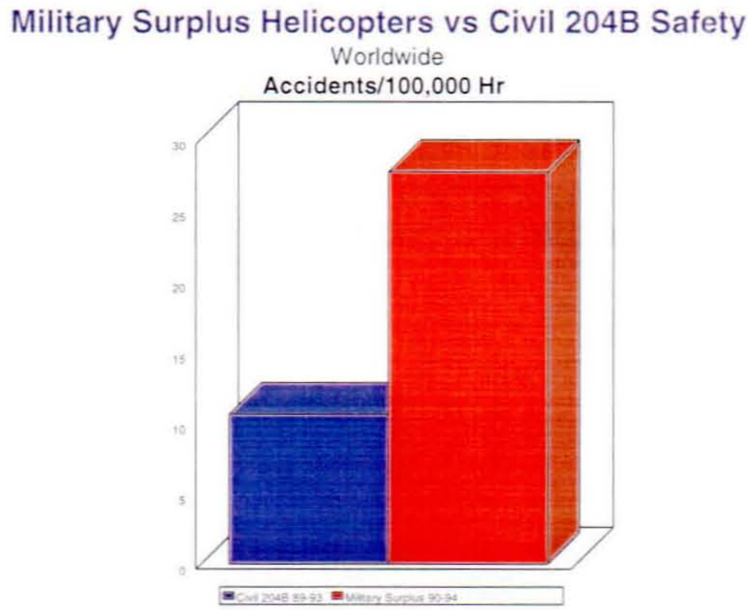
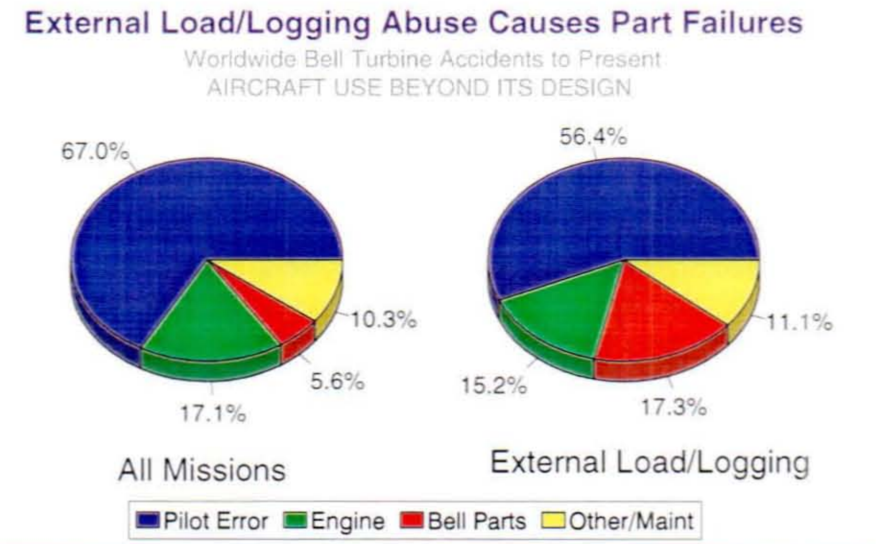


Figure 3. Accident Causes are Different in Logging



QUESTIONS AND ANSWERS

UNIDENTIFIED VOICE: On a couple of your charts you shared the world versus the U.S. statistics on accidents; why were there no accident statistics available for the 214B in the United States?

MR. FOX: The FAA has a serious problem of knowing what is out there. They lump the 204B and all the UH-1Bs, Ls, Ks, and all those together. In the 214 arena, they lump the 214 ST, a twin-engine, 20-place machine in the 214B, which is a 15-place, single-engine machine that's for a totally different mission.

UNIDENTIFIED VOICE: Well, there's only about one or two 214 STs that have ever operated in the United States. I mean it'd be easy to break those numbers out, wouldn't it?

MR. FOX: It's not a question of being easy, it's the way the FAA operates. When they send out surveys to you guys, I hope you all are responding, because they generally don't get a good response back. That's the way they group their models, and that's why I don't have 204Bs in the U.S. for the same reason, because the FAA doesn't break down the hours. I can tell you the accidents, but I can't do the exposure.

One of the things I'd like to say to you, as an operating group, all you guys together, is put together your flight hours so that you've got some information. You don't have to rely on what you heard this morning. You need to know how many hours you're really flying in logging. That really needs to be pulled together as an industry.

I've mentioned the Gulf of Mexico and the ASAC organization. Well, members of that organization, different companies, submit their total hours for the year, and they're published as a total group for the Gulf of Mexico, and that's why they look so much better. You guys have got to start working together on your overall image.

MR. MARK LINDAMOOD (Carson Helicopters): You mentioned earlier that it wasn't the engine, it was other parts made by other manufacturers. My accident was a freewheeling unit exploding. Several other people that were involved in these accidents experienced the same thing. You're the certification man. I mean your factory built the aircraft and okayed these parts, and they were 204 parts with thyroid injections that boosted them up to a 214 part, and so, eventually, after a few guys got killed field testing the aircraft, then you went to a bigger, heavier clutch assembly. So, I think that Bell should take a little responsibility for that, on that chart, and say that it is your aircraft.

MR. FOX: I understand your sensitivity to this, and I probably would be saying the same thing sitting in your chair. The clutch was not the best we ever did on the 214B. We've learned a lot about clutches since then.

I'm not trying to shirk the responsibility, sir. There's nobody that wants that any more than the operator. You know, the manufacturer has a vested interest beyond the people that got hurt and lost the machine. We have a vested interest because we may have that same problem throughout the world and we need to get the problems corrected as quick as we can. And that's why Bell pays for investigators to go out, at company expense, and support the investigation, to find out what these problems are and fix them.

MR. LINDAMOOD: Well, one other comment about your investigators. On my accident Bell sent two investigators out. Their Bell pilots flew the 214 back into the log landing and they thought it was acting funny so they punched it off from about 100 feet, so that kind of screwed up the accident investigation a little bit, because it had another crash from their dropping it. Then the clutch assembly, the whole clutch assembly was lost at Bell. They couldn't find the parts when it came time to actually get into the thing. So, when a manufacturer goes out to investigate an accident, I think that there might be a little bias in that and we need to have more people from the FAA and the NTSB looking into these things.

If the FAA did their jobs, there wouldn't be a lot of these problems. But they sit on their hands and they argue back and forth between each other's agencies. The FAA and the NTSB need to get out there and investigate these accidents, along with the manufacturers, all of them, Sikorsky or Bell or whatever, but keep an eye on things while they're doing it and make sure that there's no bias or anything that might help protect the manufacturer's interest.

MR. FOX: Well, I must respond to that. Let me tell you what is in place to make sure there's not even a question of that. We do not investigate an accident, we support the investigator in charge. Here in Alaska it will be the NTSB or the FAA. Either way we support that investigator. If it's Forest Service, we support the investigator.

Now, when there's a questionable part we offer our lab's assistance at no cost to the investigating agency or the operator if they want to bring the part to Bell. If they do that, they send it to Bell, and it is under the government control. We call the local NTSB guy, say the part is here, when do you want to look at it? He says, tomorrow. So, tomorrow we open up the box with the NTSB person there and say, "All right, here it is." An inventory's done. "What do you want to do?" The NTSB says, "Let's do this, let's do this, let's do this." And we just go with whatever he wants to do. Then when it's finished, we say, "Sir, where do you want it sent?" And he'll turn to the operator if he's there, and say, "Where do you want this part? Do you want it scrapped or do you want it back?" He says, "Yeah, I want it back. Send it to this address." We box it up and send it.

We do that to make sure that Bell never has control of that part and the investigation is always under the control of the investigating agency, whether it be military, U.S., or foreign, or civil. It doesn't make any difference. We don't take those parts.

Now, what you're talking about is a real old accident. And I really can't speak for that far back. But a manufacturer cannot have people thinking like you're thinking. We just can't. We have to get out there and find out what it is and get it fixed. In one case the investigation was over and our investigator was still looking around. He found a part that broke, so he went and got the NTSB guy and said, "Come back and look at this. This part's broken." We could have kicked the leaves over that, but that's a waste of time; it's a waste of people, and it's going to happen again until we fix it. So, we want it right there, find out what it is, and fix it. That's why we try to get the parts sent to us instead of the NTSB lab, because if a helicopter crash occurs and it's sitting behind a DC-10 accident in the NTSB lab, guess whose parts are going to get the priority for a few months? So, it won't be the helicopter. We need the information now so we can get Alert Service Bulletins out.

MR. WARD WINTER (Helicopter Services, Inc.): In regards to shoulder harnesses and seats, I would really like to see manufacturers do some work in these areas. Whoever recommended wearing one of those shoulder harnesses for ten hours a day while leaning out of a bubble never tried it, because he won't make it through the day.

Most of the seats that we have in the helicopter logging industry are things that we've juryrigged and slapped together ourselves trying to make it comfortable enough so that you can stay alert and awake for a 10-hour logging day. I would like to see some real advances in that seat design. I've already had a neck operation for this stuff and I don't want another one.

MR. FOX: Yeah. I understand what you're saying, and in fact that 412 seat is far more comfortable than any 212 seat. People never liked the 212 seat, but it's inexpensive. So everybody goes with the cheaper one instead of going to the more expensive one. My second comment on the restraint systems, is that you use a horse collar type where it doesn't go up together as one unit. It comes around kind of as a loop and then it's sewed in back. It's not rubbing on you all the time. You're wearing it, basically. But that's something you can change, too. You can do that on your existing aircraft; you can change your shoulder harness.

MR. LANDY DOUGLAS (Kaman Aerospace): The K-MAX has got an FAA qualified seat for 20 gs down, 16 gs forward. It's designed by Simula and meets the FAA crash standards at this time. The other thing is, we have a collapsible cyclic that helps, and we, as a manufacturer, in K-MAX are addressing the safety issues.

WEATHER AND TERRAIN HAZARDS IN HELICOPTER LOGGING

By Phil Kemp, Maintenance Director, Silver Bay Aviation

Combining weather and terrain into a single subject matter is an appropriate means to address two seemingly separate issues, which in reality are inextricably combined. As we separate the two subjects, we will see these two natural features remain connected at all times, both driving and limiting helicopter logging operations; terrain providing the impetus for the business, while weather is one of the principal constraints on operation.

All helicopter logging operations challenge the capabilities of both personnel and the machinery being operated. Most aspects of helicopter logging remain constant throughout North America. While sales may be selected due to rugged or inaccessible terrain, the helicopter provides harvesting methods in areas that could not otherwise be accessed, and a means of moving logs to existing roads, landings or water drops for transportation to market.

While most helicopter logging takes place in steep, rugged terrain, helicopters have played an important part in harvesting timber in swampland and other areas which would not permit the operation of heavy ground equipment. It also allows select cuts in sensitive areas such as watersheds, or salvage sales for windblown or fire damaged timber.

Helicopter operations may place both personnel and equipment in areas of extreme exposure -- on cliffs, steep mountain sides, confined gullies, or simply along the edges of standing timber. This is not to say that helicopter logging is intrinsically dangerous, but a consciousness of hazards, good communications between ground and air crew, and sound safety practices will minimize risk to both crews and equipment.

Exposure exists for helicopters logging steep slopes or confined areas with standing timber, since terrain angles may bring the aircraft into close proximity to both ground and trees. These same areas pose a risk to ground crews from falling limbs or snags dislodged by the helicopter rotorwash.

Main or tail rotor strikes (i.e., rotor contact with any object) will cause an immediate reduction of lift or control of the helicopter. In severe cases it may cause drive train, engine or structural failure, resulting in an immediate forced landing. It could result in uncontrolled descent and impact. Tree coverage and steep terrain may exacerbate this problem further, with possible further impact damage to the helicopter and occupants.

In the event of an accident, the only practical, expedient means of access may be by another helicopter. Most large helicopter operations utilize a support helicopter for choker and crew transportation, with a combination of the two providing for evacuation in the event of an incident occurring to the other.

Many helicopter logging operations are carried out in remote or inaccessible areas. This requires that every person on a crew must know what resources are available locally and how to rapidly mobilize them. This may mean other operators, helicopter and fixed wing medivac organizations, or military and Coast Guard operations. As in all emergency situations, response time and training are the keys to a positive outcome.

Water, more of an Alaskan issue than the Lower 48, is the final consideration of terrain. Incidents involving water are more likely to occur while ferrying the aircraft than during logging operations. However, water drop operations are not uncommon in coastal Alaska and British Columbia. Consideration for ground crews involved in water drop operations include adequate flotation and survival equipment on the worksite. It is important, when ferrying an aircraft, to ensure that adequate flotation, survival, and emergency equipment is carried at all times and that it is appropriate for the time of year and number of personnel on board. Modern Emergency Locator Transmitters (ELTs), with current satellite tracking systems, will bring a rapid on-location reaction by the Coast Guard or other emergency service to the most remote, inaccessible location, irrespective of weather or time of day.

Every aspect of weather affects the operation and production of both the helicopter and personnel involved in the logging operation. The altitude and air temperature of operations affect the performance of the helicopter, both in engine power output and rotor efficiency.

Density altitude is the combined effect of ambient air pressure and temperature by which all helicopter performance is calculated. Essentially, the higher the air temperature or altitude, the less the performance of the helicopter. The lower temperatures and elevations of Southeast Alaska provide for good performance year-round. It should be noted that most of the medium lift helicopters are commercial variants of aircraft designed for maritime operations and as such, provide their best performance in this environment.

Weather is generated by the movement of air at differing pressures, containing moisture, which comes into contact with changes of temperature or terrain and generates the familiar weather patterns we experience. Wind, precipitation, fog and clouds are the everyday weather we must work in, and Southeast Alaska has its fair share of each.

Rain has documented but unconsidered effects on both rotor and engine blade airfoil sections, and can cause deterioration in performance. Current research being conducted by NASA is attempting to quantify these effects. The principal consideration for operators are the effects of water erosion on main and tail rotor blades, causing increased maintenance and repair costs. Blades are equipped with replaceable bonded nickel steel strips, stainless steel or plastic tape to protect the exposed leading edges. Extreme erosion may result in premature component rejection.

Perhaps the most significant danger from rain, or any other form of water, is the contamination of fuel both in bulk storage and within the aircraft fuel system. The gas turbine engine depends upon constant combustion to operate. Interruption of the fuel supply, even by small amounts of water, can cause a flame-out, resulting in total power loss. Daily sampling of aircraft and storage tanks prior to any fueling operation, correct handling of fuel transfers, the use of water separators, and suitable NO-GO filtration units should eliminate virtually all danger of water.

Snow affects operations, in both air and ground operations. The initial problems occur in traveling to and from job sites and in preparing the aircraft for flight. On the ground, snow may be so deep as to not permit safe or efficient operation of the woods crew. It may also bury cut timber to the point it may be impossible to operate.

Icing can occur at virtually any time visible moisture exists. It can be predictably forecasted any time low temperatures (below 40 degrees F) with visible moisture occur. Ice accretion affects engines and rotor systems, degrading performance of both. The cycle of ice formation and shedding is a function of design and ambient conditions. Most damage occurs in the path of shed ice; turbine engine compressors are particularly intolerant of ice ingestion which causes power loss or engine failure.

Rotor system icing is limited on blades, the flexibility of which allows shedding of ice at regular intervals. Again, the shed ice trail is where the most danger lies. Engines are provided with anti-icing systems, with inlets and intakes being heated electrically with engine bleed air or by engine oil to prevent the build up ice in these particularly prone areas. The fact that ice can form anywhere water is present highlights the necessity to keep water out of the fuel system. Icing in airframe fuel systems is a very real hazard, resulting in power loss.

All helicopter logging operations are conducted under Visual Flight Conditions. Avoidance of terrain requires that all aspects of the helicopter operation be conducted either above, below, or around weather. Weather curtails operations more than any other operating factor. The visibility restrictions of all types of weather range from deteriorating visibility caused by rain or snow, allowing operations to continue, to having cloud and fog shut operations down completely.

Logging operations carry on around these localized weather patterns. Care must always be taken to ensure that suitable alternative landings remain open during operations around fog. Maritime and mountain areas are both prone to fog. Certain locations exist where aircraft have been unable to operate successfully due to the extremes of localized weather. Since the predominance of these weather patterns occur during fall, winter, and spring, they combine with short daylight hours to pose serious constraints in running profitable and productive operations.

Although very uncommon, lightening strikes have occurred during helicopter logging operations. Damage to electrical systems is generally minimal; however, damage to the aircraft and its systems may be massive and require replacement of all components in the helicopter. Damage is caused by the massive charge of electricity passing through the aircraft. At every point of contact without minimal resistance, arcing can occur across gears, bolts, or whatever is in its path. The resulting damage may destroy the integrity of any affected component or part. As they attempt to pass to ground, most lightening strikes will enter and exit the helicopter through the main or tail rotor blades. Consideration of the charge passing through the long-line and striking the ground crew should be assumed to be potentially very real.

Wind affects operations both positively and negatively. The effect of wind on a hovering helicopter, nose into the wind, is to increase the amount of lift generated by a given power setting by virtue of increased airflow over the rotor system. Conversely, wind from inappropriate directions or downhill winds will degrade performance as well as extend flight paths as the helicopter maintains its head into the wind to maximize available power and controllability. Excessive winds cause problems both with controllability of the helicopter and of the hook. Additionally, wind adversely affects crew comfort and performance in the aircraft, coupled to unwanted structural loading of the aircraft. Turbulence and gusty conditions further affect them. Every helicopter type and individual crew will have some limitation.

Many of these conditions can affect a parked helicopter. Strong winds or extreme snow falls can snap or bend rotor blades, blow the aircraft and its equipment around landings, or even blow the aircraft over. Ice storms can result in aircraft becoming temporarily unflyable as ice builds (even within assemblies such as blades) and the helicopter cannot feasibly be de-iced until a thaw commences.

When planning helicopter logging operations, consideration must be given to the landings and the affect their location has on the overall operation. Are landings of suitable size, with appropriate flight paths for prevailing or anticipated winds? Are flight lengths long or short enough for efficient operations? Is the flying uphill or downhill? Will the helicopter type being operated work efficiently within all these limitations?

Similar considerations need to be given to service landings. Is the surface satisfactory or will the landing require watering to minimize dust and consequent erosion? Is it suitably drained? Does the landing provide adequate protection from prevailing weather or wind? Does the morning sun shine on it to assist in winter de-icing operations? Can you get fuel in all weather conditions? Failing to consider all options in the planning stage of an operation may result in serious problems later.

A final consideration of the combined effects of weather and terrain in a logging environment concerns emergency situations. The recovery from many emergency situations in helicopters depends on the pilot's taking immediate action. This may be acceleration of the helicopter to provide increased rotor lift to counter reduced power. It might require diving the helicopter to produce speed to recover altitude and control, or in the event of a total power loss, to maintain adequate rotor RPMs to facilitate an autorotative landing.

Alternately, should a loss of flight control be experienced, establishing a high airspeed may be essential in order to maintain control of the helicopter to perform a run-on landing or an autorotative landing in a confined area. In either of these circumstances, constraints of weather or terrain may seriously limit available options, which in turn significantly reduce the success rate of recovery from emergency situations.

These circumstances are very real. The worst accident that occurred in Southeast Alaska involved a loss of control in deteriorating weather and daylight, resulting in an attempted autorotative landing within the confines of a rock pit when weather and terrain eliminated all other escape routes. Take any of the circumstances that are contained in this paper and combine them in any sequence and find the limitations or areas of risk for your particular operation.

Finally, no consideration of hazards of terrain and weather could be complete without the most contentious issue in helicopter logging -- twin-engine versus single-engine logging. Many of the scenarios we have considered involve the course of action following power loss. Many individual causes may result in this outcome. The course of action to be taken must consider the available power, altitude, air temperature, weather and terrain to effect the most appropriate recovery. This consideration is, of course, academic. If you had only one source of power to start with, the immediate requirement is to find a suitable forced landing site within autorotative distance.

Some of the statements made at this workshop regarding the performance of twin-engine helicopters are totally uninformed. Helicopters configured for logging operations are stripped of all extraneous equipment and are operating at an empty weight that provides for all maneuvers to be performed on one engine. History has proven this point. The safety record for twin-engine helicopters involved in logging operations stands comparison with any other twin-engine helicopter operation. The same, sadly, cannot be claimed for single-engine helicopters involved in logging operations.

It must be added, however, that many of the accidents involving single-engine helicopters are not due to failures of engines or related systems, but to failures of drive train or structure that have historically consistent failure rates, or failure to comply with operating limitations. The combined activities of operators, regulatory agencies and manufacturers have resulted in positive action to address the issues. If we meet in 1996 we will be able to assess their impact on the industry. Safety is not achieved by good fortune; it is achieved by hard work, planning and determination. The same or greater effort is required to maintain the standard that has been achieved.

Awareness of emergency procedures, localized weather systems and terrain, forced landing sites and the preparation of plans for the evacuation of injured personnel are the required steps taken by operators to minimize the risk to personnel. Who to contact, how to contact them, and what local emergency resources are at your disposal are the keys to rapid reaction and the keys to enhancing the survivability of any life-threatening situation.

HELICOPTER MAINTENANCE IN HELICOPTER LOGGING OPERATIONS

By Ron Smith, Maintenance Foreman, Erickson Aircrane

I've been in the industry for 16 years, and most of that has been in helicopter logging. I have some strong feelings about maintenance issues that I'll share with you. Almost all helicopter maintenance is performed on-site. Everything involved in maintenance -- personnel, tools, supplies, parts -- works out of a van located on-site. The size of the helicopter determines the level of service. Larger units are served by both a day and night crew.

Finding qualified people for helicopter maintenance can be difficult; experienced personnel are hard to come by. Thus, we do a lot of training, usually on-site.

The day shift typically arrives at the service landing with the pilots, helps get the helicopter going for the day, and spends the remainder of the shift fueling the helicopter and fixing any problems that come up.

The night shift arrives in the late afternoon and relieves the morning shift. The night shift does any scheduled inspections or heavy maintenance that's due. It really has to pay attention to everything. In logging the helicopter is being used on more arduous tasks than it would be if it was just flying light sling loads. Stress from the constant vibration shows up in the airframe, in components, in the wiring; it shows up on just about everything on the aircraft. The maintenance crew needs to inspect the aircraft thoroughly, right back into the furthest corners, to find any defects, repair them, and have the helicopter ready for use the next day.

At Erickson we run a five-person maintenance crew. Two mechanics are on the morning shift and three mechanics are on the night shift. The third night person is usually in training. He might be in training six months or longer before he's actually able to sign off the aircraft and return it to service. It takes quite a while to get a mechanic trained for helicopter maintenance. You pull new mechanics out of the general aviation sector, put them into large helicopters, and the first month is pretty much just standing there looking at it flying by. They're all in awe of what's going on.

Helicopters use lots of parts and pieces. Logging with a helicopter tends to identify the weak areas in its design. At Erickson, we've changed a lot of the design flaws over the years. Our policy has been to identify the problems, and not just try to live with them from day to day, but change to a new and better design. When I first started working on Skycranes, for instance, it was very difficult to fly them eight hours a day. We spent half the day working on this model. Today, however, after many design changes, we have a good dependable helicopter that can fly all day.

Maintenance personnel should give inspections a high priority. We should always look to find that one extra thing that's a potential problem. From the pre-flight in the morning, to the post-flight at night, to the phased maintenance, or the 100-hour, to what the overhaul shops are doing on the gear boxes or the engines, inspections tell you the health of your helicopter. A lack of trained inspectors is one of the weak links in your overall system. When maintenance is a company-wide priority, everybody can contribute to overall safety.

Another safety concern is the smaller and smaller landing areas. Within this limited area, besides the helicopter, there is a maintenance van, at least one fuel truck, several pickups and maybe other vehicles. If a pilot attempts to make an emergency landing, a little extra room could make the difference between a successful landing or an accident. The same limits affect log landings. A little extra room could make all the difference in an emergency.

I heard the comment made that no matter what part of the world that you're in, all parts are the same. That's not true. The climate makes a tremendous difference on the storage of parts, especially those that contain magnesium. In less than optimal storage conditions magnesium parts pit and start getting weak areas where cracks occur. Right now we're working in Southeast Asia to learn how to preserve parts in those climatic conditions, and how to keep them ready for use and in serviceable condition.

In Alaska, rainy weather is a problem, and I'm sure the rain causes corrosion problems. Thus when a helicopter is secured for an extended period of time, its iron will rust while its magnesium and aluminum will corrode. There's lots of training to be done about adaptation to weather conditions.

QUESTIONS AND ANSWERS

MR. DALE HOKE (Aerial Crane Systems): When you compare the book maintenance requirements to what you actually do, how do you vary from the written regulations? I'm assuming it's more, that you're doing more maintenance than is legally required by the book on that particular aircraft.

MR. SMITH: Oh, you definitely have to do more than is required by the book. If you were to look at phased maintenance, and try to inspect the aircraft just according to specifications and not go further than that, you would have serious problems in no time at all. We look at many things much more often than the manufacturer's recommended guidelines.

MR. MIKE BARR (University of Southern California): What is the turnover rate for your mechanics? How long do they stay there before they move on to the next place?

MR. SMITH: I've been very fortunate in keeping qualified personnel. We're expanding right now, and since I pull a lot of my personnel from our overhaul shops and hangar, they're generally people who have worked for the company for quite a while. My turnover rate is next to nothing, actually. I've had maybe two or three people in the last year who have moved on to other companies. Qualified people make the difference in this industry.

MR. TIM HARPER (Erickson Aircrane): One of the things you talked about was changing the way you do things through inspection. The sense I got was that the management in maintenance has to accept responsibility to gather data and get the pertinent information back out to field mechanics. One procedure in which this takes place is through maintenance memos. How can we use the memo to greater advantage? How do you gather that data and put it together so that you can advise all the crews of potential problems that they should look for, as we conduct logging operations?

MR. SMITH: I think such a policy has to come from within the specific industry. I don't know how to address this issue for the helicopter industry as a whole. You have so many different types of aircraft, so many different types of companies. Each industry has its own system. If, within our company, we have a repetitive defect, we gather up information about that defect and we try to eliminate it. If there's an airworthiness problem, we want to know about it and we want to cure it as soon as we can. I'm sure Bell has lots of methods for addressing the safety factors on each model they have. How do we do this risk-reduction industry wide? I think that's what we're beginning to discuss today.

DR. GEORGE CONWAY (NIOSH): When you have a finding about either additional maintenance or changes in equipment, do you share those with the manufacturer if it's anything that requires approval?

MR. SMITH: To explain our procedure, you should understand that there's two parts to Erickson Aircrane. We bought the type certificate on the skycrane. The manufacturer is upstairs and the repair station is downstairs. We keep a lot separate between the two entities, but when safety's an issue, we're able to directly influence the phase, the inspections, and different things, almost immediately.

DR. CONWAY: Do you regard those changes that are made as proprietary, and therefore, a property that you'd want to hang onto, or do you share findings about additional maintenance?

MR. SMITH: Most of our findings related to safety issues are shared with the other operators. Most of the skycranes out there have the same modifications on them for product improvement, regardless of who owns them.

Legally, if the manufacturer makes any changes with paperwork or anything that's done with that type certificate, those modifications have to be shared with other 64-E operators.

REGULATIONS AND STANDARDS IN EXTERNAL LOAD OPERATIONS

By Don Study, Former Director, Labor Standards and Safety, AKDOL

Regulations provide a level playing field for all the actors. Everyone has to abide by the same requirements within the industry. We find, in construction and other fields as well, that there's always some new player out there trying to cut corners, trying to come in with a low-ball bid just to get the contract, by not complying with safety standards. They may go out of business, but their losses hurt the industry in the long run because the industry takes the blame. That death or that property loss is attributed to the industry as a whole. Also, the insurance rates apply to the industry as a whole, and everybody's insurance rates go up because of it.

I don't know exactly how the FAA comes up with some of its standards and regulations, but the majority of the OSHA standards came from industry. When OSHA was first formed back in 1970 with the Occupational Safety and Health Act, most of the standards and regulations it enforced were initiated by industry. For instance, one industry had been demanding a confined space entry standard, because there were too many people dying in confined spaces in the United States. But how long do you think it took federal OSHA to develop a confined space standard? Fourteen years! Fourteen years after the industry asked, the agency finally came out with a standard.

If an industry could self-regulate, I'd say that's great. But if that's not possible, government regulation may be the only way to accomplish the control that you need. I say again, the losses hurt the whole industry, not just one operator. We all are affected by insurance rates, reputation, and so forth.

The Alaska Safety Standards are covered in the logging code, 07.175, paragraph (a) through (d)(2) (Appendix, page 115). Unfortunately, the code requirements do not always reflect the realities of the field. For instance, the code reads, "Helicopters must comply with any applicable regulations of the FAA. Every practical precaution must be taken for protection of employees from flying objects in the rotor downwash. All loose material within 100 feet must be secured."

How do these regulations fit the reality? Because the Forest Service doesn't want certain trees removed, the sales are getting smaller and the landing sites are getting smaller. Now we see rotor wash with 70-80 mile an hour winds in a smaller and smaller landing zone with people down there next to danger trees. You're supposed to secure everything?

The code also states that, "Whenever approaching helicopters while running, individuals shall remain in full view of the pilot" and requires that, "Employees shall avoid cockpit rearward unless authorized by the operator to work there." The reference is to maintenance people. We just had, late last year, a situation where an individual asked a helicopter pilot for a ride. The pilot, who was refueling, said "Yeah, I'm going to be leaving in just a second, so hurry up." The passenger appropriately went to the rear of the aircraft but walked right into the tail rotor and sustained immediate, fatal injuries.

Again the code states, "Air crew and ground personnel shall receive instruction in proper communication, either hand or radio." This regulation ignores the fact that the logging company and the aerologging company are two separate entities. One company seldom employs all field workers at a logging site, so there needs to be an interface between those two companies to ensure that all of the employees do have adequate training.

Another section of the code states that, "Flight path shall not be above employees. Weight of load must not exceed manufacturer's rating. Helicopter operator is responsible for size, weight, and manner in which loads are connected. If, for any reason, lift is unsafe, lift shall not be made. Landing zone must be 125 feet from loading area." The FAA may not agree that the State of Alaska has authority to enforce these standards, particularly ones related to operation of the aircraft. It's my understanding that anytime the operation of the aircraft is involved, FAA regulations preempt federal or state OSHA. As far as ground personnel and operations are concerned, federal and state OSHA have control, but not in the actual air operations.

Another part of the code requires that, "Certificates issued by, and governed by, the district office in the pilot's residence area have jurisdiction." Jurisdiction of remote locations, routinely, are not handed over to the local office. If your certificate was issued in Salt Lake City, jurisdiction remains with Salt Lake City.

In my previous experience, I judged that what was happening at remote locations was never looked at by the FAA. In fact there was one situation in which the location of a camp was unknown. We had to relay the appropriate information to the people involved so they knew where their operations were and could go check them.

Many accidents occurring in Alaska can be linked to a violation of one or more of the following regulations:

"Operator must be or have services of a commercial or Airline Transport Pilot (ATP) available. Chief and assistant chief pilots must be commercial or ATP."

"Chief or applicant must demonstrate proficiency to FAA. Compliance not required of previous experience, and safety records show knowledge and skill are adequate."

"Only if one is a crew member, is a trainee, or performs essential functions, is one allowed on the helicopter." I didn't see any provision for carrying passengers.

"Demonstration may be made to the chief pilot, assistant chief pilot, or in a logbook entry indicating flight check or a letter of competency."

"It must not exceed the total weight approved for the rotor craft."

These regulations illustrate the maxim that what regulations do not say is just as important as what they do say. What minimum hours are required for pilots, other than chief pilot or assistant pilot, to qualify for commercial or ATP standing? There are no limitations on flight crew hours. However, we know from research on human factors that too many hours in the cockpit puts the body and mind on autopilot. The individuals are there physically, but not mentally. Notice, too, that regulations do not require any inspection by the FAA office where the logging occurs. In fact, regulations do not even require the chief pilot to be at a remote location.

There's no requirement for increased maintenance to meet the increased cycles and wear on the aircraft.

There's no commercial or ATP requirements for the pilots in general, other than those for the chief and the assistant chief.

No requirement seems to exist for adequate maintenance facilities. In Alaska especially, we are affected by harsh operating conditions and bad weather. Around Southeast you get a lot of saltwater, a lot of salt spray. If you don't think that goes very far from the beach, live in one of these communities up on the hill. You'll be washing salt spray off your windows 300, 400 feet up from the water. It travels a long distance, and will affect logging operations.

Quality of pilots, as far as I can find in the standard, is totally dependent on the company's ethics and standards. Some of the insurance standards may require specific hours and specific training, but it isn't discussed in Part 133.

In the demonstration of a typical operation to the FAA for external load operations, there's no requirement other than what was given to the FAA at the home office. If the conditions change in a remote site or if there are different operational parameters, the FAA will not take that into consideration with the certification process with the companies.

One final concern about FAA policy is that when we first started dealing with this issue we questioned why there wasn't more involvement, more regulations. And the individual I was talking with referred to the pilots, saying"They know it's hazardous when they get into helicopter logging." I hope that was just that individual's thoughts and not the attitude of the agency as a whole.

In my opinion, helicopter logging can be accomplished safely, but only with sound safety practices. I've heard some of those sound safety practices already voiced in this room. The extraordinary hazards associated with this type of flying demand the highest standards in pilots and equipment.

QUESTIONS AND ANSWERS

MR. RANDY ERWIN (Erickson Aircrane): Earlier I asked a question of someone else in here about the first accident we discussed this morning. So many things about that accident were gross. The question was, how is it that the FAA allowed that operation to continue? But the State of Alaska has the same regulations. Although it's unclear whether or not they can regulate an operator while he's in the air, they could certainly take away his business license, or impound his equipment to make him cease and desist if he's violating the state regulations.

MR. STUDY: The problem is with the state regulations. If we don't have jurisdiction they're not enforceable.

MR. ERWIN: So, basically, this section of the Alaska Logging Standards that has to deal with helicopter logging that we're talking about, is unenforceable even though it's part of the standards?

MR. STUDY: I would question its enforceability as far as actual flight operations go. Anything on the ground is another story.

UNIDENTIFIED VOICE: And the question I would have is, why can't a state enforce it? As I understand it, as a matter of law, a state can promulgate and enforce a regulation that is equal to or more stringent than a federal regulation.

MR. STUDY: We can have standards that are equal to or greater than federal OSHA and enforce those standards. But, if we are preempted by another federal agency, that federal agency takes primacy over enforcement.

MR. MARK LINDAMOOD (Carson Helicopters): In Oregon if you break regulations, hard hat regulations or high visibility clothing, the first time you're fined a certain amount. One way of controlling operators who are violating safety acts, is to fine them. Fine them again, and then take it to court if they don't want to pay it.

MR. STUDY: Yes. That's based on ground operations.

MR. LINDAMOOD: It has nothing to do with flying?

MR. STUDY: Flying is FAA's jurisdiction.

MR. LINDAMOOD: But your regulations are speaking to flight and ground operations. That's where I'm confused. The regulations you're saying are enforceable are speaking to ground operations. In fact, we have many of those same regulations in Oregon, and they are enforceable; in fact they *are* enforced.

MR. STUDY: The regulations I was referring to were concerned with weight of the load. It may not exceed manufacturer's specifications. That's an FAA rule.

MR. LINDAMOOD: That's taken from 133?

MR. STUDY: Yes. Helicopters must comply with any applicable FAA regulations. That's enforced by the FAA, not state OSHA. If it pertains to ground operations, state OSHA will enforce it, and has enforced it.

UNIDENTIFIED VOICE: It seemed to me that you were possibly advocating a little more regulation to clean up our act. My point is, the regulations are there now. If people are held to task to follow those regulations, a lot of these problems may not have occurred.

Now, if a gear box is going to fall off a helicopter, I don't know if that's because the pilot was continually over-grossing it or not, but the regulations are there, and a lot of these things wouldn't have happened if people had been following the regulations, or if the agencies responsible for enforcing the regulations had done their job.

Maybe we need to change the enforcement structure, rather than adding more regulations.

MR. STUDY: When we first got involved with this, the FAA didn't even know where you were located. They didn't have a clue where you were.

MR. LINDAMOOD: But we're not talking about the FAA, we're talking about your state agencies. And it says in one of your regulations, that you can't exceed the helicopter's manufacturer weight ceiling. If that's in your regulations the state should be able to enforce it. If a state inspector walked out to one of these sites and picked up a bunch of cycle sheets and saw that they were overloading the aircraft 14 times a cycle, why doesn't he fine somebody before a bunch of people are killed?

MR. STUDY: The main reason was jurisdictional. Our folks, at the time I was there, did not investigate helicopter accidents. The National Transportation Safety Board has the responsibility for investigating those accidents, and the FAA has the responsibility for the enforcement of their regulations.

MR. WARD WINTER (Canadian Helicopter Logging): I think most of the pilots who have been around a while have all been in those operations before. In some of them I've wondered how the guy I was working for kept operating. I was doing it because I needed a paycheck, but I was waiting for the FAA to come along and slap his hands. I don't think we need more regulations; we need to enforce the ones that are in place. Whether it's a state agency, a federal agency, or anybody else, somebody has to have jurisdiction. I know a pilot who had his license jerked after he killed about 40 people. The next day his wife had the certificate and he was back in operation. It's criminal sometimes.

MR. STUDY: I'd like to ask one more question of everyone. Who would you suppose would have the best answer for solving all the problems we've talked about, as far as losses that have been experienced within this industry? Who is best suited to come up with those answers? It's not the FAA, folks. It's the people sitting right here in this room.

UNIDENTIFIED VOICE: It's a panel of operators who have been operating for 20 years with a decent safety record.

MR. STUDY: It's the people sitting right here in this room. I looked over the list of everyone attending this meeting. The solution to this whole problem is sitting right here in this room.

UNIDENTIFIED VOICE: That's today. But the next time you have a good log market, every "gypo" who can buy a UH-1B will be in there logging. We don't have any control over them except to say, "I'm not going to fly his aircraft."

MR. RON SMITH (Erickson Aircrane): And we go one step further. You can't pin this on the FAA. We're talking about operators going over long distances with no regulation. But, within this system is another huge anomaly. Surplus aircraft that are restricted category do not require an operator's certificate.

MR. STUDY: I feel this is the industry right here, and the members that need to find the solution to that problem. If there's no other way to do it, there's always the option of the industry itself asking for a regulation, written as the industry wishes.

THE BUSINESS OF HELICOPTER LOGGING

By George Warren, Chief Pilot, Columbia Helicopters, Inc.

Most of us who have worked in the helicopter logging industry for very long have developed a great deal of admiration and appreciation for the leaders in this industry. Wes Lematta, Jack Erickson, Bud Kaufman and Duane Cross are all examples of people who have had a huge influence on helicopter logging through their hard work, insightful innovation, and tenacity. The problems facing helicopter logging have been unique, requiring unique solutions. The men running these operations have been genuine pioneers, forced to find solutions to problems not encountered before. Their pragmatism has enabled them to follow their vision through to a productive conclusion. Another essential trait shared by the industry leaders is a hard-headed business sense which has enabled them to temper their innovations with prudence. This helps prevent over-extending their operations, most of the time.

The cost of operating large helicopters is enormous and can come as quite a shock to operators of smaller and intermediate-sized aircraft, who try to extrapolate their costs and operating experience with smaller machines up to logging-sized helicopters. Many operators have been overwhelmed by these costs and operational problems when they tried to step up to heavier equipment. The fact that this has happened many times to successful operators of small and intermediate-sized aircraft has demonstrated the enormous difficulties inherent in helicopter logging with big helicopters.

A fundamental characteristic of the helicopter logging industry is its volatility. Wide price fluctuations of log prices on the domestic and foreign markets are normal. Also normal is an increase in logging helicopters coming out of the woodwork whenever there's a significant spike in log prices. Many non-logging operators have succumbed to the temptations to field a large logging helicopter when log prices are high, convinced that it's a sure fire way to make big money. The reality is that helicopter logging is an extremely marginal endeavor with profit margins averaging just a few percent. Many timber sales make no money at all and others lose money. Any operator entering into this activity without sufficient capital to weather the dry spells will find himself in a marginal financial situation in a very short time.

The question that naturally follows is why would anyone be in this business for over 20 years if there's no money in it? The answer is common to any operation involving expensive equipment. As utilization increases, the cost of the operation decreases. Flying logging helicopters as much as possible enables the operator to keep utilization up, which in turn increases the likelihood of realizing profits from other lift projects such as power line construction, roof top sets, or even the occasionally profitable logging job. This strategy, however, requires a long-term commitment of personnel and resources.

One of the essential aspects of efficient helicopter logging is safety. Our firm has long realized that cutting corners is a false economy that can jeopardize equipment and personnel as well as the balance sheet. Strict adherence to regulations and aircraft limits is stressed again and again to all personnel.

In spite of all our best efforts, however, incidents happen. Unfortunately it has long been a fact of life in aviation that many incidents or accidents can be blown way out of proportion by the media and the public. Recent heli-logging accidents in Alaska, while unfortunate, do not reflect the experience of the industry in general. For instance, Columbia Helicopters alone has flown over 100,000 logging hours in the past ten years without a flight crew fatality. Other reputable heli-logging companies can cite similar data.

A further attempt has been made to characterize the hazards to helicopter logging in Alaska as greater than those found in the Lower 48. The fact is that many conditions in Alaska are more favorable for helicopter logging. These include lower ambient temperatures and a lower timberline, which enhance aircraft performance.

During the last twenty-four years the helicopter industry has shown itself to be a safe and effective means of removing timber when conventional methods were not viable. Helicopter logging has adapted successfully to a wide range of terrain and timber types. The crucial ingredients to the success of this industry have been the willingness of an innovative management to commit resources on a long term basis to make heli-logging safe and effective.

QUESTIONS AND ANSWERS

MR. DALE HOKE (Aerial Crane Systems): How much training time do you give your pilots before they're allowed to fly in logging operations?

MR. WARREN: Well, with us, training is a two stage operation. New personnel start out as copilots and then their external load training begins in a light aircraft. We operate a Hiller or a 500, and they usually spend 30 or 40 hours in it until they can demonstrate competency. Then they may move over to a larger helicopter, where they may get up to 100 hours of supervised long-line training before they're turned loose on their own.

MR. HOKE: So, with luck, it may take a season until you feel comfortable turning a new pilot loose?

MR. WARREN: No. I think we can do it in much less time than a season. We can probably do it in four or five months, if everything in our training process runs smoothly.

MR. MARK LINDAMOOD (Carson Helicopters): Of course, you're talking about a pilot who's already got some experience. This would not be a guy who just received his license, correct?

MR. WARREN: I can't speak for other operators, but we don't even hire people to come to work until they've had 1,500 hours pilot-in-command time in helicopters. I think that's probably a general standard for the industry as a whole.

UNIDENTIFIED VOICE: During your upgrade time and your proficiency time, how do you document the training that you give new personnel, each hour? Do the captains who fly with him write up a sheet, or do you have a document that you keep?

MR. WARREN: We have a training form, which screens for all of the various facets of training, and progress is indicated with a numerical grade. There's also room for comments which we encourage. After the form has been filled out, the pilot signs it, goes over it with the trainee, the trainee signs it, sends it in to us, where we keep it in his file.

UNIDENTIFIED VOICE: Apparently, you're using an industry checklist to test for proficiency. So, in fact, you're doing a procedure that goes above and beyond what is present in the 133 FARs.

MR. WARREN: 133 says that you'll train to competence. Mercifully, it doesn't tell you how you're going to do that, unlike a lot of other regulations try to guide your hands. A new pilot is either competent or he isn't.

UNIDENTIFIED VOICE: Is that competent in sling-load, or competent in the type of aircraft?

MR. WARREN: He has to demonstrate proficiency in both.

UNIDENTIFIED VOICE: Under 133, is it required that he be type rated in that aircraft?

MR. WARREN: No, because it's already covered under Part 61. If it's a large aircraft, he has to be type rated to function as a captain, or as a pilot.

UNIDENTIFIED VOICE: What if it's a 9,000 pound gross weight aircraft.

MR. WARREN: If the aircraft doesn't require a type rating, then the answer to your question is yes, he would have to demonstrate competency in the aircraft in normal transition procedures, and he would also have to demonstrate competency in external load operations.

UNIDENTIFIED VOICE: If I understand it right, you can do 133 without being 135; is that correct?

MR. WARREN: Sure.

UNIDENTIFIED VOICE: Does 133 require a pilot to be type rated?

MR. WARREN: No, it doesn't, because the requirement is already covered in other regulations.

UNIDENTIFIED VOICE: I think what the question intends to ask is, if you go out and demonstrate proficiency under Part 133 in a Hughes 500, and you're issued your little card that says you've demonstrated proficiency, might you be able to jump into a 206? With loopholes, you don't have to take another check ride or demonstrate proficiency to anybody in that 206, according to Part 133.

MR. WARREN: Was that your question?

UNIDENTIFIED VOICE: That's my question. I wanted to learn more about your documentation process with new pilots. 133 does not clearly describe how operators should document the training of new personnel. Obviously your outfit is documenting. You're working to a syllabus. Unfortunately, that doesn't necessarily mean that the next guy who comes along with a helicopter will follow the same process.

MR. WARREN: What you're saying is correct, and again I don't want to trivialize it. But can you cite me some accidents that were directly attributed to the fact that an operator didn't document the training process adequately?

UNIDENTIFIED VOICE: I am aware of a case where a pilot's training wasn't documented. The company had no paperwork, and we couldn't find where he had practiced these maneuvers.

MR. WARREN: Then he didn't demonstrate competence.

UNIDENTIFIED VOICE: He might have. I don't know. We couldn't find any record. Now, obviously you have a record, so that solves the problem.

MR. LINDAMOOD: Based on your experience in the business of helicopter logging, how much would you estimate it costs to train a pilot with 1,500 hours, to be a production pilot in a 107? How much money do you think the company spends on training, as he's learning until he finally gets up to where he can go out on a logging job, and do a very safe job?

MR. WARREN: You know, I'm reminded of some people from a government agency who were asking for what we felt was proprietary information. They assured us that nobody would ever find out because all they were doing was gathering information for various makes of aircraft to show in general what the operating costs, et cetera, were. All that their findings were going to show were averages for the type of aircraft or the make of aircraft. However, since my company is the only one that operates 107s and Chinooks, the data for the 107 and the 234 are obviously going to apply only to us. So, your question may involve information that applies only to our company.

MR. LINDAMOOD: I was asking the question because, as you mentioned earlier, when the log market becomes more profitable, the "gypo" loggers pick up people whom they've trained in 25 hours, and it doesn't cost them very much. But our company may decide not to train, but to hire people who already have a 5,000 hour minimum requirement to come to work. Last year we trained somebody new, and it cost us a few hundred thousand dollars. When I tell people that, they don't believe that training could cost that much. However, when you look at what it costs in production, it does cost that much. Your company has an excellent, wonderful, safety record, but you spend a lot of money doing that. However, you get the dividends back in the end.

MR. WARREN: That's exactly right. I think one of the things that we've discovered over the years is that a safe operation is an economically viable operation. When you start cutting corners on safety, be it maintenance, pilot training, or anything else, it turns out to be based on a false economy, and it comes back to bite you in the end. Anybody who is cutting corners on any sort of safety regulation, whether it pertains to flight safety, or ground safety, or any other area, will cause the loss of industry-wide respect for the quality of that company's management. They will also be operating under the general perception that they're not going to be in business for much longer.

A previous speaker said that a lot of the solutions to the problems that we're facing lie with everyone from the industry right here. It's a point that we should take very seriously. If we, as operators, try to stand apart from one another or constantly be concerned about somebody getting a competitive edge on the other over every little thing that comes down the pike, and if we don't work together on a lot of these issues, we're going to all fall separately. This call to action may be one of the best things that ever happened to this industry. It may serve as a wake up call because, if we act on it, we can progress and go forward and continue to be a growing, viable industry.

UNIDENTIFIED VOICE: George, do you think that the restricted category in the states has any effect on the heli-logging? Since you're involved with operations in Canada, do you feel that it would also affect that country, having a restricted category?

MR. WARREN: Do you mean if we continue to have the restricted categories as they currently stand? It's hard for me to say too much against restrictions. We operated under those guidelines for years. I don't know that I agree with one of the previous suggestions that operators need to purchase only new equipment, because of concerns about the safety of used equipment.

MR. ROY FOX (Bell Helicopters): It's the salvage parts, the military surplus that I was talking about.

MR. WARREN: I don't have an argument with that. But there are constraints. The provisions allowing restricted category aircraft to be operated under 133 came about as the result of a pretty shaky deal. The way that was finessed through the FAA isn't anything I'm very proud of. But I think it still goes back to the integrity of the operation, the integrity of the operator. If the restricted category aircraft is operated safely and in accordance with the regulations that are in place, which are perfectly capable of ensuring a safe and efficient operation, I don't really see that much of a problem. I'm not a big supporter of restricted category aircraft, but we have operated them ourselves.

HELICOPTER ADAPTATIONS FOR EXTERNAL LOAD OPERATIONS

By Randy Erwin, Chief Pilot, Erickson Aircrane

Let me start off by saying thank you to Jan and Mike for having us all here. I think our conference is quite beneficial. This is probably better than the Helicopter Association International, although maybe not as much fun as Las Vegas.

I am not a logging pilot, never have been, probably never will be. I do have about 8,500 hours in helicopters, and a great majority of those hours have been spent with an external of some type hanging below me. My remarks here are directed to those people who have come here to learn about the helicopter logging industry or external load industry, and not necessarily to all those people out there who have been doing it forever.

I'm reminded of a plaque on the wall of the chief flight instructor's office of my first job. It said, "Those who claim to know all there is to know about aviation are particularly annoying to those of us who actually do." Having said that, I hope this audience will not be too annoyed.

The helicopter is really a unique machine. Whether it's got one, two, or three engines, its capabilities to hover motionless in space and go up and down and fly around like an airplane lend themselves to a tremendous variety of applications: medivac, observation, cargo delivery, survey work, seismic, gravimetric, magnetometry, electronic news gathering, EMS, and search and rescue. All these things a helicopter can do, and do exceptionally well. Long-line logging may be the most unique application for the helicopter.

The military should take credit for having paid for the initial development of the helicopter, but I don't think anybody in here would argue the point that the commercial operators are the ones who really exploited the unique capabilities of the machine, from hauling bank paper around rooftops in downtown Los Angeles to setting crab pots and harvesting them out here in Southeastern Alaska.

But, each of these tasks, each of these helicopter applications, requires different capabilities, different skills by the pilot. External load and vertical reference skills, I believe, are among the most demanding in the helicopter industry, although some may argue that IFR work or some of the other things are equally as difficult. Regardless, the pilot has to have these unique skills to take advantage of the helicopter. The operator also has to have some unique skills or different practices to exploit the machine. As another presenter pointed out, the maintenance practices are definitely different for a logger than they would be for a Part 135 charter outfit, or a news gathering company, or a flight school.

Logging helicopters, as I've told many people on several occasions, are better maintained, better looked after, than any other 135 helicopter that I've ever flown or am aware of. Helicopters used in other operations may have prettier paint jobs, get washed more regularly, but as far as maintenance is concerned, these logging helicopters are maintained to a much, much higher standard. It's because the bottom line is profitability. You can't do this business without being safe and efficient about it. It's just too expensive.

What I'm here to talk about is how the unique capabilities of the helicopter relate to external load operations. I've been trying to think of an example to give to those of you who are not helicopter pilots, who have never flown a helicopter, what it's like to perform an external load, vertical reference operation. If you get in your car, line it up in the right-hand lane, with the centerline, the yellow line just outside your left door, then open the door up, stick your head out and drive away, just watching the yellow line to keep yourself on the road, you might be doing the task equivalent of long-line logging. Driving that way might give you an idea of what the helicopter pilot does when he's trying to navigate and control the helicopter by looking straight down.

When you learn to fly, you have a horizontal reference which you use to keep the helicopter level. When you want to move it from level, you change the attitude of the helicopter reference to the horizon. But when you look straight down along this long-line, you lose that reference. You no longer have any kind of reference as to what is level, what's flat. So, your mind's eye starts taking pictures of this long-line as it departs the helicopter, the angle it makes on the skids or the landing gear, the fuselage, and that's how your mind figures out what is vertical. If the long-line is vertical, then that must mean that you're horizontal so you're going to stay in one place until it starts swinging. This is where these unique skills develop in the long-line pilot. He's constantly having to keep track of where the load is, whether it's an empty hook or an 18,000 pound log or a bucket of cement, where that is in relation to the helicopter, what the long-line is doing in relation to the helicopter, and whether the helicopter is level or in some other attitude. When he gets this angle figured out between the helicopter and the long-line, then he can exploit the mass of the load and the inertia, to allow the load to swing around and let it go where it wants to go, and then get on top of it. This way, the pilot controls the load. At least that's what he tells the copilot, "You know, I meant to do that."

As Mr. Lindamood so aptly pointed out, a guy in a single pilot operation is real busy. He's trying to keep track of all of these things, plus keep track of his power management with his little calibrated elbow there, and talking to people on the radio, and worrying about obstructions that he can't see but he remembers, or he thinks he does. These are extremely demanding tasks.

I flew helicopters for about eight years doing external load work before I ever saw a bubble. I thought that was the neatest thing since sliced cheese. Bubble windows that protect the pilot from the elements were a tremendous advancement in this business. So were arm rests, torso rests, shoulder rests, things to make the helicopter pilot more comfortable so he can sit in the helicopter for ten hours a day. It would be nice now if they came up with some kind of a restraint system, a shoulder harness that you could wear and still perform your function.

Outside instruments were another advance. If you're hanging your head out, you can't see the torque, NG, T5, NR. You can't see the caution panel. I've never been in a helicopter with an audio caution panel, but in any of these things, you're constantly dividing your attention between the load, and the line, and the belly, and the guys on the ground, and the obstructions, plus all the equipment in the helicopter, so outside instruments contribute greatly to overall safety.

Load cells are another improvement. This one instrument, which doesn't have anything to do with helicopter operations normally, tells the pilot how much weight is on the hook. It doesn't weigh the helicopter, it just weighs from the hook down. It's a pretty neat device.

Operating the helicopter from the left-hand seat is another change currently used by Hughes aircraft, that has resulted in safer operations. Flying from the left-hand seat makes it a lot more comfortable. You're not leaning away from the collective, you're on top of it. English or American helicopters, have a normal lean to the left, so if you're sitting on the left, particularly in larger helicopters, there's a lot of freeboard, like inside an S58 or a 61. Sitting on the right-hand side really makes it difficult to see what the hell's going on down there. There have been a lot of modifications done to the seating on Sikorskys to better adapt them to this left-seat operation.

Remote hooks are another improvement. A remote hook is another pretty dandy device that allows the pilot to control what's going on at the end of his hook rather than waiting for a ground crewman to come and unhook him. It contributes to the overall safety of both flight and ground crews.

FM radios have also evolved over the last ten or 15 years, allowing the pilot to communicate with the people on the ground. I've heard stories that at one time, one logging operation only allowed one radio out in the whole unit. Now I think just about every person out there has a radio in a vest so if he has a problem he can tell somebody about it. And there's a lot of problems to be told.

Some of the other things that have been mentioned were specific to the airframe adaptations. Long-line logging is probably the most abusive thing that you can do to the helicopter. I don't mean to imply that anybody is willfully abusing the helicopter, but it is just intrinsically an abusive thing to do to the machine.

So when the inevitable part failure occurs, you replace the most frequently-failing parts with something better that doesn't break as often. I think Thomas couplings on Bell products were a problem so they put K-flex couplings on them. The exhaust extensions on the 64 had a big problem with engine stator veins cracking, so we put harder mounts on.

One of the neatest things though, I think, that has been adapted to the helicopters was designed by a guy sitting right here in this room. Dale Hoke designed a logging shock. It cut down tremendously on the wear and tear.

MR. HOKE (Aerial Crane Systems): I can only take part of the credit.

MR. ERWIN: Anyway you look at it, the external load operation is an incredibly demanding task for the pilot and the operator. One of the habits that any successful external load pilot has developed, is a real thorough preflight planning. He'll make sure he's got enough fuel to finish the job, he'll be aware of the condition of his helicopter, and he'll conduct a good preflight. The operator has to have a real commitment to safety as well. He will ensure that the pilot has all the tools he needs and that he contributes what he can to make sure his camp is a safe environment. A safe environment is a less costly environment in the long run.

HELICOPTER LOGGING FROM A GROUND CREWMAN'S PERSPECTIVE

By Jim Neal, Safety Manager, Aerial Forest Management Foundation

Thank you for the opportunity to be here. As has been stated by quite a few speakers already, I think that the answers to the industry's problems, or perceived problems, are in this room.

Born and raised in a logging camp, I consider myself an experienced logger. I've worked on the rigging, on the landing, and as a timber faller, under yarders, and behind Cats. Since 1971 most of my woods work has been under helicopters. I started in 1971 setting chokers, then worked as a timber faller and as a woods boss.

My experience leads me to disagree with the problem statement we're working on tomorrow. It states that workers involved in helicopter logging are at an increased risk of serious or fatal injury. What is the comparison group? Is a choker coiler at more risk than a bartender in a bad part of town at night? Is a pilot at more risk than a loader operator? In general, from a ground crew's perspective, helicopter logging is the safest form of logging in the woods. Everybody out there has visual and radio contact with the yarding engineer or pilot at all times. Nothing moves until he says to go ahead. Experienced pilots with whom I have worked may at times see something I didn't. Then even if I've already said "clear", the pilot won't clear or start picking up the load.

I have two boys; the oldest one is 22, and they just broke into the woods with my uncles in the last three or four years. I was much more concerned about their breaking in under a yarder than I would have been had they had the opportunity to break in under a helicopter.

From a landing perspective, sale designs are a concern. Normally helicopter landings are larger and more complex operations than government agencies, typically the Forest Service, will allow for yarders. To me, a yarder landing in general is a much more scary place to be than a helicopter landing.

It's hard to say that cutting is more dangerous on a helicopter job. Because you tend to be on steeper ground, all the dangers associated with cutting on steep ground apply to helicopter logging. You tend to do more partial cutting. Thus, in one sense there's some increased risks, but in another sense, because you've got a lot of stems standing there to prevent logs from rolling, it's actually safer.

I'm fairly amazed at some of the comments I've heard. I said I started as a choker setter in 1971, but I've heard today from a couple people that this is an emerging industry. As early as the 1970s, Columbia had fantastic training programs as did Erickson and Croman. I was trained in the woods by my uncles, and my dad. I've trained I don't know how many people in the woods myself, rigging crew people, cutters, landing people. I've never read a rule to them, nor required them to read a rule or regulation. I think we kind of have to ask ourselves, "What is the real purpose of rules and regulations?"

Part of what I do now with Aerial Forest Management Foundation is travel around the country helping public and private land managers lay out and design helicopter logging sales. One of the questions I'm constantly asked is about helicopter safety. I always ask them, "What do you mean? Are we talking about saving lives, or are we talking about not being subject to fines?" These are two completely, and sadly enough, unrelated items in many cases.

There's certainly a place for rules and regulations. I think we have to sort out, as a group, what we expect them to accomplish. Bureaucratic agencies tend to see problems and work toward their solutions. It seems like whether we're in land management changes, or safety, or whatever it is, the answer ultimately ends up including a bunch more rules and regulations. I think we have to be very careful about using that to solve our problems.

On the industry side, if we don't want the government to come up with rules and regulations, then we've got to police ourselves. I think the operators that have been around a long time have done a good job of this.

I would just caution this group that I think we really need to ask ourselves what are we going to use rules and regulations to accomplish? My partner, Jack Montgomery, hooked the first helicopter turn ever. He has compiled a list of things to look out for, for different jobs, and it's written not in the form of rules, but suggestions. "If you're a choker setter, watch out for these kinds of things, and here's some things to keep in mind."

One regulation that's probably helped this industry more than anything is the policy regarding drugs. The drug test does appear to influence safety in our industry, and it's nice to be sober.

OPERATIONAL AND AIRCREW FACTORS
IN HELICOPTER APPLICATION

By Robert Bertoldo, D.O., M.P.H., Flight Surgeon, United States Air Force

I would like to address a few models of analysis with you today. Earlier this morning one presenter described the public health approach -- agent, host, environment. I call this the dynamic environmental approach -- man, mission, and machine -- matrix or triad. My focus is on the changing environment that affects all three of these areas continually.

I will need to define a few terms that describe operational factors or mission-oriented factors, the conditions related to how a specific mission is accomplished. Then I'll discuss the air crew factors or human factors, and how they impact a mission.

We've already identified some of the problem or potential problem areas in regulations and directives. Problems occur when regulations are not exceptionally well spelled out. There are some other ideas concerning directives that I have found in the literature and I'm basically presenting information from general aviation and military aeromedical literature on these subjects. But the literature suggests that perhaps an instrument rating currency, although initially required, should not necessarily be maintained throughout the term of employment.

Insurance companies are evaluating the risks in flying in mountains and asking if pilots should be required to study a curriculum for mountain flying, have some designated areas, and require pilots to be certified in this training, before they provide coverage.

Helicopters are inherently deadly. According to 1990 NTSB data, the rate of fatal crashes per million aircraft hours flown for unscheduled events or unscheduled flying, is 14.5 for helicopters versus a rate of .82 for all other aircraft. So, almost 18 times a greater rate. The numbers are awfully high, but I verified that they were reported correctly in that literature.

Let us look at some of the other things concerning equipment, crash survival ideas and concepts. When we look at helicopter crashes, for example, fire becomes the most significant predictor of death. Fires might be involved only ten percent of the time, but associated with 56 percent of the reported fatalities. So, crash-worthy fuel systems I feel are very important, and the military has done extensive training and research in this area, and for the cost of 11 gallons in fuel space and the added weight of 25 pounds, the military can ensure a crash-worthy fuel system in its helicopters.

Many civil, commercial operations use pre-1970 technology with respect to crash-worthy seats and fuel systems. We feel that with the existing technology, 95 percent of the current crashes could be survivable. The Navy and Army have done extensive energy attenuation research and have systems designed, tested, and deployed in their experimental models. Their newer concept aircraft can withstand a 58.5 foot per second deceleration, which includes 99 percent of all accidents. And that's consistent with about 56.6 vertical gs impact.

In addition, there's been extensive work on helmets and the protective features of the helmets. One thing they've been trying to get away from are the hinge fractures at the base of the skull, which have been a continual problem.

Now I'd like to discuss training. In the past we've considered a reactive approach. Once there was a mishap or something happened, then we got all excited and started looking at all the concerns and all the possible solutions and what was impacting it. In the future we want to be more proactive, and I think we're coming to an age where this has become a lot more sophisticated, and we really are including a proactive approach. We're teaching air crew and aviation leadership the effects of stress on safety and accident prevention. We're looking at the human system as an integrated system in the development of an overall aircraft system.

We notice that also in training, the Army reported 92 percent of their mishaps occur in the daytime, with experienced people. In general aviation, more instructor rating is consistent with about a 50 percent decrease in the predicted accident rate. Also in general aviation we notice that younger pilots even with more hours tend to be more willing to accept risks than reject a mission. And we have another observation that in the military at least it seems there might be a negative byproduct of flight training. Maybe this might bring on some overconfidence in one's skills and judgment, and an unrealistic optimism regarding the chance to avoid harm through personal control.

A study that looked at preflight planning and supervision in general aviation reported no flight plan was noted in 83 percent of accidents. This lack of preflight briefing and the potential for in-flight hazards and threats, emergency items or changing weather conditions, going into IMC conditions, just adds one more stress to the pilot who is already taxed with a lot of things. We feel that it's important to recognize in planning and supervising, that we match the flight plan to the experience in the model and with the familiarity of the local flight environment and the mission of that aircraft.

The duration of flight mission is another important aspect to consider in operations. Mission stressors may not be actual flying, but circumstances of irregular meals, fatigue, or the fatigue of prolonged flight. We notice significant changes in ability to function and cope, and increasing fatigue, after up to seven hours of continual operation, according to a study of 24 flight crews doing C-5 operations during Desert Storm.

Under climatic conditions, we notice in general aviation that 92 percent of crashes occur in VFR conditions; 84 percent occur in daylight. We feel like the issue of "pressing" in the face of deteriorating weather conditions is the most common cause of fatal general aviation accidents. Training in IMC conditions is essential to maintain currency.

In helos, the number one weather-related accident cause is associated with wind factors. The number one fatal accident cause is associated with fog, low ceiling, and rain. Sounds like a lot of what we've been talking about.

Next, if we look at vibration and noise, we notice a condition where severe vibration can actually cause a type of spatial disorientation that cannot be recovered from. This doesn't happen too often. Usually it's associated with the total breakup of the airplane, something catastrophic happening to the flight controls. But the low grade continual noise and vibration, which is present in all helicopters is a form of stress, and it is also, in certain frequencies, a contributor to low back pain.

Lastly I'd like to talk just briefly on work site environments. The stress of a work site, which is a remote site, is a recognized stressor. We look at the environment of handling an aircraft, that is equivalent to one of the highest task stressors of a helo pilot over other aircraft pilots.

In selection, customarily and traditionally, we've always looked for the "right stuff". Generally we've identified an older pilot as a safer pilot, while the younger pilot, regardless of his experience, is willing to take more risk. And we've decided that pilots attending safety clinics score high on internal locus of control. Well, these are the kind of characteristics that we want to be selecting for.

Under crew changes and rotations, there's an added stress from an absence, or a period of absence. And this risk needs to be recognized and it needs to be included in the supervisory aspects.

Under requirements for crew rest and nutrition, the Air Force has a standard of 12 hours of crew rest, four hours of free time and eight hours of sleep. We surveyed some of the C-5 transport crews and found that less than four hours of sleep, pre-mission, contributed to the following behavioral degradations: fumbling with radio frequency changes; slowed speech, slowed decision time, dry mouth; impaired judgment; difficulty comprehending controller instructions or frequency changes, and poor acknowledgment; diminished checklist discipline, decreased cross checks, decreased crew coordination and increased irritability.

Nutritionists have noted for a long time that lack of protein and calories is a recognized stressor. I recently received a briefing from one of our medical commanders from the air transportable hospital which was stationed down in Cuba with the refugees. The military set up a huge tent city and surrounded it with wire to contain this group. The prisoners were getting two meals a day. They had beans and rice for breakfast, then had an MRE for their last meal. This went on for several months. Finally, some of the refugees broke out of the wire, and went up into the hills. They just disappeared, then came back with three-foot long banana rats, and added those to their diet. In nutrition matters, variety is also important.

Under task management and fatigue, it's noted in the literature in general aviation that greater than 50 percent of the accidents occur from faulty decision making. Also it's noted that a male pilot is two times more likely to experience an error or a pilot error mishap than a female pilot.

Increased quantity and complexity of tasking in flight, which are secondary to in-flight changes, contribute to fatigue. The military noted in helos that the more tasked a pilot becomes with aircraft control, the more challenged he is by any kind of unexpected change. It's just that the normal workload is so much, and especially for a single pilot. We fly some special mission single-pilot aircraft in the Army but primarily all our cockpits are dual piloted.

We find that excess emotional stress caused by family problems, social stress, career instability, recent or near aircraft accidents, and difficulties with flight schedules, creates a failure in a pilot to cope, or at least challenges the coping mechanism. This can lead to clinical depression. It can lead to self-destructive behavior in which a pilot externalizes his feelings, acts out, and blames others. When you see expressions of defensiveness, arrogance, hostility, financial irresponsibility, excess routine habits, these all lead to, and are spelling out, fatigue and it's time to recognize that there will be decreases in pilot performance. There will be increases in risk taking that follow, however, and we all know what follows that.

Judgment training, or "aeronautical decision making," has more safety improvement potential than total elimination of all airworthiness failure causes, according to Mr. Roy Fox. I have a lot of respect for him making that kind of a statement.

There are three determinants of pilot performance: ability, personality, and attitude. When we look at ability, we can only teach and instruct so much. There's only so much talent and ability in a person to grasp and actually have skill and do things. Personality is fixed early in childhood. Where we feel we can get the most bang for our buck in the military is in the aspect of attitude. And this is where we direct our current aircrew coordination training.

Now I'd like to discuss spatial disorientation of which there are three types, one, two, and three. One is recognized, two is unrecognized, and three is incapacitating. It's also called the vestibular-ocular disruption. The most likely form that we see in pilots who fly helicopters is in the type two, unrecognized. Customarily this is in the period or phase of flight of hovering. And it has to do with the lack of some of the vestibular inputs that tell you that you are moving, and it is interesting to note that type two is the one that seems to be the most picked up in helicopter operations in contrast to other aircraft, fighters, and so forth. And this type two, unrecognized spatial disorientation, is generally noted in the context of a high workload environment.

I'd like to just talk briefly about ergonomics: sitting in an awkward position, flying a helicopter and being task-saturated for hours on end. Originally, it seems man was an afterthought. The machine was designed, man was then inserted into it. A good example for me, being in the aerospace medicine environment, is Alan Shepard's Gemini capsule. If any of you have ever seen it, it's an engineering marvel. However, I also think it's a marvel that a human being was able to fit inside one of those and actually function. And I think it's aptly named, a capsule. Now we're looking more and more towards fitting the job, or the work station, or the tool, to the operator.

A helicopter is a rotor-winged aircraft platform, which is an unstable flight platform just by nature. Meaning it cannot be trimmed to fly itself. It requires constant pilot control during all phases of flight. And this is a setup for more fatigue from increased workload.

Lastly, a look at emergency crew functions. A helicopter pilot must be psychologically prepared to ride it to the ground. A successful autorotation will result in the dramatic decrease in longitudinal and vertical velocities. Imagine then, if this process or this event is not practiced with some kind of currency, it's not being done, and then suddenly the pilot is caught being faced with a situation requiring it. I think that's another added form of stress.

Finally, crew health and medical conditions. I just want to remind everybody that in general aviation more than ten percent of fatal accidents are related to alcohol.

I'd like to also just mention that if the crew has been down for more than two hours, or if the aircraft went down secondary to sudden failure, this will increase the time to rescue. If it also went down at night, it increases recovery time eight times. If it goes down in the mountains, it increases the rescue difficulty and time to recovery six times. In IMC conditions, four times, and if there are fatalities, an additional 3.5 times.

You might be interested in some of the helmet improvements that the Army has done. They've improved their impact protection, and this is from a flat impact spread out over a large surface area, but basically making it twice as safe, or twice as able to sustain gs.

At greater than 500 hours flying time, we start to see a drop in mishap rates. But up to that, the mishap rate is higher. The Army integrated a program for expert pilots, to find out what their judgment process or development process was, and to try to make that part of training. And what they noted was that there was a reversion to the basic airmanship skills. Basically, there was no substitute for experience. But even with experience, there's a need to keep coming back to the basics.

In summary, I think there's a lot of things that we can learn, a lot of parallels that we can make between general aviation, military aviation, and what occurs in the aerologging industry. I offer those for your consideration. Obviously, we need to make specific applications depending on the mission.

QUESTIONS AND ANSWERS

UNIDENTIFIED VOICE: What about crash resistant fuel cells? Are they self-sealing?

DR. BERTOLDO: Self-sealing. Yes. They have a valve system.

MR. ROY FOX (Bell Helicopters): The self-sealing is a misnomer. The military have it in the crash-worthy fuel system. It is a bullet proofing. There's a layer of natural rubber between the two outer layers, and as the bullet goes through, and the fuel comes out, the natural rubber swells up, seals it up so you don't leak gas, so you can fly home. It does you no good whatsoever in a crash. None. Zip. There is a commercial crash resistant fuel system and it is now regulations, finally. We've started them in our aircraft. Back in 1976 we put a military one in, but it weighed so much we couldn't tolerate it, so we went to a civil version, which is what the FAA rules are now.

Basically, going from a standard bladder, say an old 212, to a 412 with a commercial crash resistant fuel system, it'll cost you about three times the weight penalty per square foot of bag. To go to the full military, like the Army did, it'll cost you about eight times. But you don't gain any extra live people. So, in the commercial world we said we don't want this extra capability. It doesn't save any extra lives. So that's when we went with the lighter weight material. Our experience shows we've cut our post-crash fires by about half, and that's including the non-survivals as well.

MR. PHIL KEMP (Silver Bay Logging): Most of the helicopters don't have crash-worthy seats, and most of them have no head restraint system on them. Did I pick up that a neck hinge injury is one of the most common injuries, serious injuries?

DR. BERTOLDO: It is the most common serious injury. It's more of a hyper-extension injury than a flex forward injury.

MR. KEMP: Most of the seats, unless installed in a helicopter with a bulkhead immediately behind it, there's nothing. Your head's going to go right back over that seat.

UNIDENTIFIED VOICE: And then if you hit the bulkhead, it's probably going to do you no good either. It's going to injure you further.

UNIDENTIFIED VOICE: There's the requirement you have a headrest on the aft facing seat. The requirement's in there.

UNIDENTIFIED VOICE: Right. But we have not seen this extension problem that way. Our problem has been in the forward direction and the lateral, and if you don't wear a shoulder harness it ain't going to work anyway. You just as well have taken it off.

UNIDENTIFIED VOICE: Right.

DR. BERTOLDO: Lateral is a real problem, and the new helmet was strengthened on the side to take more gs.

UNIDENTIFIED VOICE: Most of the new helmets, to my mind, weigh too much. Like I mentioned before, I've had my neck operated on for this stuff. I had nerves pinched off at C-5 and C-6 that started an atrophy in my left arm, and now I'm down to a David Clark headset with a David Clark beanie cap on for the light weight. When I lean out and put my neck out all day long, that's about all I can take.

UNIDENTIFIED VOICE: I can remember back when we first got the doors on the 61s for the cockpit. I felt like I could log about four hours longer than I could before that because of the noise reduction in the aircraft, plus the fumes and everything else that used to come forward through the cockpit while you were logging, because comfort and noise reduction probably, for the pilot, would give him a lot longer hours, safe hours, in the cockpit.

DR. BERTOLDO: I agree. The helmet, the new helmet, is a half pound lighter. I don't know what it's total weight is, but it's lighter than the old model.

UNIDENTIFIED VOICE: Flight Suits Unlimited has one that's only 21 ounces, which is quite a bit lighter. That's about the half the weight of an SBH-4.

DR. BERTOLDO: What you have to do is look at the g protection, what kind of protection does it give you and what kind of sound attenuation do you get. You have to check out the specs, because it doesn't make any sense to wear one if you're not going to get some kind of protection from it.

INVESTIGATION FINDINGS OF HELICOPTER LOGGING CRASHES

By Doug Herlihy, President, The Herlihy Group

Until September of last year I worked for the National Transportation Safety Board at Anchorage. I was one of the investigators-in-charge in Anchorage. There were three investigators in that office, and we worked approximately 200 accidents a year. I think last year we investigated 208. That's about average for Alaska each year. Each investigator gets the opportunity to work about 80 accidents a year. Spreading the work between us means you can do more work on some, less on others. We've done some helicopter logging accidents here in Southeast, and that's why I've been invited here today.

Basically, your work at an accident site is to take photographs, measurements, documentation, and some of the time assist in the recovery of the victims if you're out there with a trooper or FAA inspector. We work together to gather the facts.

I've chosen an accident for discussion which is representative, and we've talked about it a little bit. I chose a 214 helicopter accident. I hope to shed some light on what happened there, so that we can fill in some things between the lines.

What I'd like you to do is look, with the focus of a wide angle lens, at some of the photographs so that you can pick out, as the experts you are, some of the things that we see here in terrain, availability of emergency landing site, and some of the connections we found, and the long-line apparatus that perhaps played a part. No accident finding is clearly outlined by causals. You can't say that this, or that, is the cause. It's a causal string of events, like dominoes.

All of you know that there's a whole series of events that goes on. Violation of regulations is often cited as prime cause of accidents. One of my jobs is to look beyond the regulations, beyond the violations. I'm not going to go back and say there it is, a violation, a regulation was broken; ergo, we have an accident. My counterparts in the FAA, who come with me on many accidents, and I, have common arguments and common agreements about the requirement for FAA regulations and their enforcement.

Let's take a look at some photographs from one accident. Perhaps we can generate some questions. I brought these first two photographs along because they may answer some questions for me.

This is a model of a belly hook removed, in the closed position (Figure 1). I just wanted to have you take a good, close look at it because we might talk about this a little bit. It's an 8,000 pound Breeze Eastern hook that came off of the 214. It's similar to most belly hooks.

Identifying a few of the items in this, we see the hook, and there's a snubber and a tang on the back. When the tang hits against the rubber snubber, it stops the unit from opening beyond a certain flexing. This is the same hook in the open position (Figure 2).

This is a variety of a remote hook that we found in the 214 cases. We found in this case, a remote hook was hanging on the long-line somewhere about 150 feet or so down from the belly hook. It's electrically actuated from the cockpit. This remote hook, of course, is the one that the hooker hooks the choker into, that hangs below the helicopter (Figure 3).

This is the helicopter over at Dora Bay when we came onto the site on the morning of the accident (Figure 4). I was with Bob Colvig and Ned Horne. The aircraft, as you can see, has rolled about 135 degrees off to one side. The pickup place was up a slope about 1,100 feet in elevation to the left of the center of the photo, to the north, and the water is to the south at the top of the photo.

The wreckage is just to the right of the "Y" in the logging road (Figure 5). The helicopter was in its fifth cycle, and I think about the fifth or sixth turn of its fifth cycle, and it was seen to come in to this position into a stationary hover and set two logs down, one on an extended choker, and one on a choker attached to the remote hook. The logs happened to sit balanced on top of each other for a moment.

The yarder operator did not see the helicopter at that moment, and looked up in time to catch the helicopter starting a series of yaws and pitches and a rolling movement in position, both left and right, up and down, not very rapidly. He described them as coming in approximately half second intervals. The helicopter was then seen to move down slightly in a descent from about 200 feet or 175 feet, out-of-ground effect hover, still wobbling in a right turn. The witnesses said they thought it was heading for the flat area right above the crash site.

Logs were still attached to the remote hook that was still attached to the long-line lying about 150 feet south of the wreckage. The clevis of the long-line stopped approximately 11 feet from the belly hook on the bottom of the helicopter (Figure 6). The belly hook was closed.

Witnesses saw the helicopter descending with rotor RPMs decaying and dragging the two logs over a distance of about 55 feet until they hung up in some snags. Descending to a point 25 feet over the stump at the crash site, the helicopter, with its line still tethered to the two logs, caught up taut by dragging the logs, and stopped its forward movement. The helicopter was seen to pitch over from that 25-foot altitude. I feel that the helicopter accident, at that point, became unsurvivable. A stump penetrated the cockpit.

We might say here that we've found that there are only three things that'll kill you in an accident: 1) the bubble that you're sitting in, the capsule, the cockpit, or the cabin, is penetrated or crushed; 2) you're either burned or asphyxiated; or 3) neither of the aforementioned factors exists, but your body, the organism, is exposed to g forces beyond human tolerance limits. You'll see ripping of the aorta and certain organs come apart, even though you're not penetrated or burned. This accident became unsurvivable at this point when the stump penetrated the cockpit.

This photograph is the view from aft (Figure 7). The helicopter's main rotor is shed, of course. One of the things we noticed here was that the short shaft, the drive shaft between the transmission and the engine, and the rear coupling had come apart (Figure 8). At first when we looked at the broken coupling as it had penetrated the cowling, we noticed pieces of it had penetrated the hull, and so we began to think we were looking at a partial problem of the short shaft uncoupling, which was contributing to the decay in the rotor RPMs. As it turned out, we discounted that. It's more likely that the coupling came apart on impact, even though we didn't find a lot of the pieces.

The aircraft rolled to about 135 degrees. We were able to get into the deck from underneath, to the transmission and the engine deck, where we found evidence that there was something wrong in the cyclic linkage. An extension of the right cyclic piston had broken from some limited-cycle fatigue right where a binding nut and some threads first show on the rod that comes out of the assembly. It broke where you would expect it to break. There was a fracture where stress risers on the rod were introduced and that's where you'd expect a break (Figure 9).

This component was photographed on scene and we sent it to the NTSB lab in Washington and then over to the Southwest NTSB office, where a second tear-down with the Bell lab was conducted. The work that we saw in that component was consistent with a binding in a spherical bearing in the center of that unit. This binding was seen when we tried to move the piston up and down through the spherical bearing. The spherical bearing had scratches on it that were inconsistent with what we'd normally see if had it been overhauled. The records showed the component itself had a history of being sent back and forth from Japan. As I remember, it was overhauled, or there was a record that it was overhauled. However, there's some question on what was done in the overhaul. So, that's where we leave it.

I hope that gives you a brief picture of the kind of inquiry that we tried to do in this one to try to find why this component could have failed in fatigue. The binding of the spherical bearing translated to bending, as the piston went up and down. Normally, the spherical bearing allowed it to flex side to side. That binding in this spherical bearing translated to some increased torque needed to move it, thereby imparting a bending force to the rod, which of course wasn't able to bend when it was down in the assembly, because it was held by a series of bearing and shims and collars all the way up through the assembly. When the rod got outside the assembly, there it could bend, and that was where the stress risers of the threads and the milling of the key were introduced, resulting in a failure. We believe the crew worked hard to fly a helicopter that had loss of pitch and roll control. That's what witnesses told us.

The investigation also identified human factors. One of the interesting things we found in this helicopter crash was a plywood bench seat that ejected in the crash. This seat was used for transporting the folks to the logging area. It's probably against regulations, but that's not the point. And of course it didn't figure in the accident. But we do see a seat that's not crash worthy, a hard wooden bench seat. It does provide a small picture of the disregard for passenger safety in this operation.

We looked at other areas concerning human factors. We found the pilot's cycle sheets with both pilots' names on them, and we brought them back and examined them and went through the numbers. Looking at the load of the helicopter, we figured that he carried off 1,500 pounds of fuel, and we verified that with the fueler.

He burned down to about 250 or so, in an hour and five or ten minutes. He had, therefore, a range of logs he could carry. Essentially all heli-logging operations work the same way. With more fuel, you have to carry fewer logs. Right after refueling, the pilot of this helicopter could carry a load or combination of logs that would be around 5,700 pounds, increasing to about 6,900 pounds at the end of his work cycle.

At the end of about an hour he had about a 1,200 pound difference in log weight limitation. Limits of the first log carried were 5700 pounds; the weight of the log at the end of the cycle was somewhere around 6,950 or so. His cycle sheets showed that they consistently carried logs in excess of 7,000 right after fueling. There were occasional notations of 8,000 pounds. This was not a one-time thing, it was done a number of times.

On the cycle that this accident occurred, during the sixth turn of his fifth cycle, in either four or five of the turns before this accident, he was overweight by 1,000 pounds. Now how does this translate to the fatigue failure of the right cyclic servo? I don't know. But the continued overload could not be discounted.

Other things were seen in the toxicology report. The NTSB required a tox report of the pilots, and found one pilot had 20 times the minimum detectable level of marijuana metabolite in his system. How does this translate to his capability to handle the helicopter in an emergency, and his job to get rid the load manually? I don't know. It does say something about the way the operation was run in terms of human oversight and stress.

I'd like to briefly discuss an engine failure we alluded to earlier that resulted in a helicopter autorotating from and out-of-ground effect hover onto a very hazardous piece of country (Figure 10). It occurred in this Bell 214 when nuts backed off from two of the cross case bolts up forward in the compressor section of the D55 engine. The two nuts that backed off were particularly hard to tighten because of their location under a bleed band. In fact, they sat in a little pocket underneath the bleed band of the number 6 opposite a hole directly over the number six compressor section. When we took the bleed band off in the tear down, we found two of the bolts had no nuts on them. When we cracked the case and got in to examine the debris, we looked particularly for debris that didn't belong in the compressor, burners, or turbine. The compressor section was fodded-out from the sixth stage aft. Everything aft of the sixth stage was destroyed.

When we did a material analysis of the particles, or just the shreds of particles, back in the hot section, some of the particles sent to the lab turned up as belonging to the two nuts . The helicopter involved in the accident had a recent engine change. It was a field installation, where someone had put the two major engine components together in the field under poor conditions, the kind many mechanics must work under.

This particular engine was put together and installed in temperatures of 20 degrees, in an open and unheated shed. FAA inspectors and I saw that helicopter going together under those conditions while on site following a previous accident. That's the unfortunate situation.

The area of that crash, quite typically, shows the degree of hazards and obstacles you face trying to crawl down through all that bucked and felled timber, from the top of a hill. It's impossible to reach someone in a hurry. These are tough places to get around. It must be incredibly tough to work.

I want to close my remarks by saying that since I've left the Board, it's interesting for me to see a part of accident investigations I hadn't seen before. Some of the things discussed this morning concern the interpretations in courtrooms of these accidents, and a belief by the public that this business is a real dangerous operation. The numbers support that it is, but what's also important is the public perception of it, and the impact of the newspapers and the media make it so.

Like in a courtroom, the public is also the jury. When the same people get to sit on a jury and decide these cases of negligence against operators, they are affected by what is printed in the news about the industry. It's very effective for plaintiff attorneys to argue negligence to the public sitting in a jury box. It's very effective. So, whatever the industry can do to control risk factors, is going to help immensely when it comes to the litigation risk affecting field operators, and the cost of doing business.

Figure 1. Belly hook in the closed position.

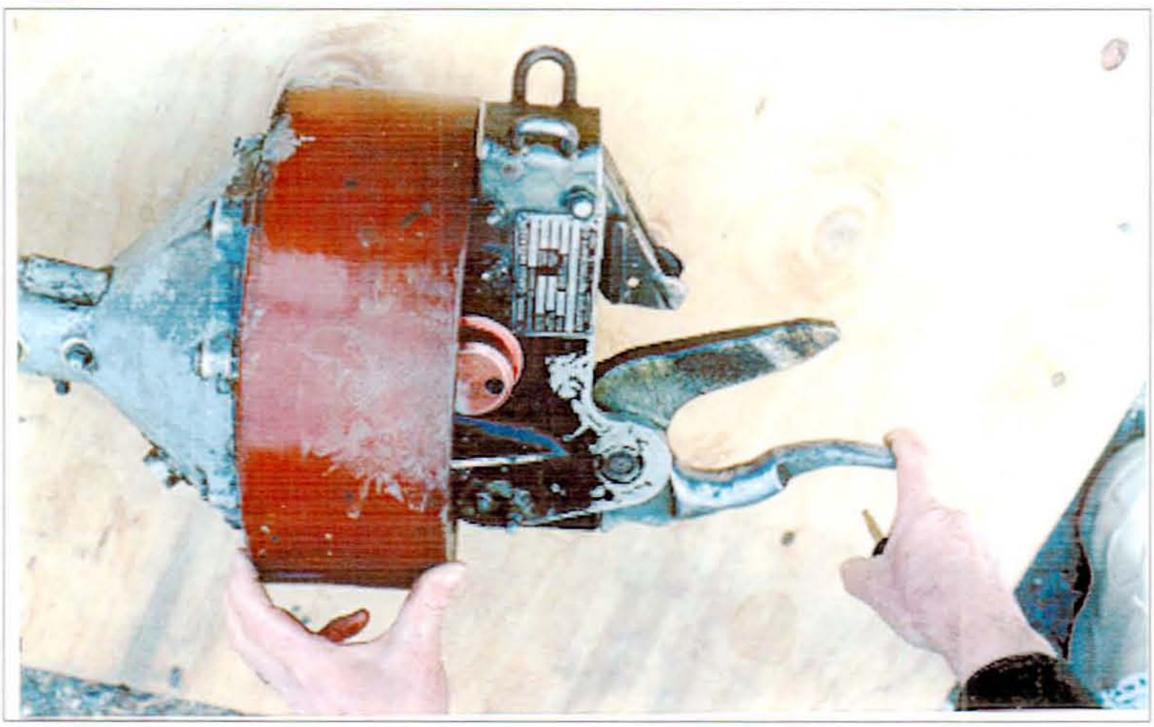


Figure 2. Belly hook in the open position.

Figure 3. Remote hook.

Figure 4. Helicopter accident at Dora Bay.

Figure 5. Dora Bay wreckage to right of the "Y" in the road.

Figure 6. The clevis of the long-line.

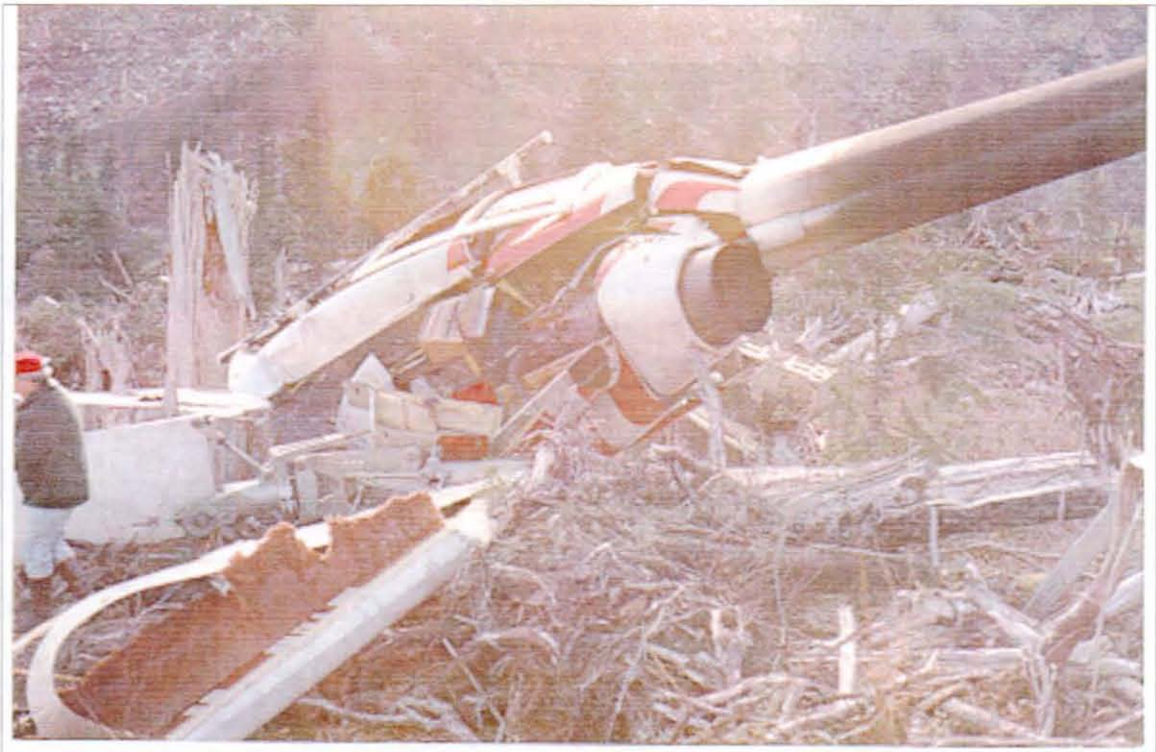


Figure 7. Aft view of the helicopter at Dora Bay.

Figure 8. Drive shaft and rear coupling separated.

Figure 9. Location of break on right cyclic piston rod.

Figure 10. Bell 214 autorotating accident.

Figure 11. 204B accident at Copper Harbor.

QUESTIONS AND ANSWERS

MR. DALE HOKE (Aerial Crane Systems): On the 214 accident, did you determine what the wind was at the time of the accident at aircraft level, roughly?

MR. HERLIHY: Yes, sir. Northeast. I don't want to quantify it and say it was no factor, but it looks like the aircraft came down the hill with a slight tail wind and turned around into the wind. However, these weren't high winds. This wasn't the case on the 204B accident that followed over at Copper Harbor (Figure 11). That pilot had a strong wind coming down the hill behind him, probably 17 to 22 knots. A strong tail wind with a load coming down. He flew around 1,200 feet and the helicopter came down with that smoking tail rotor. He did drop the load up at the top from the remote hook. Then he came down with the long-line and for some reason went into an out-of-ground effect hover above the maintenance site. He then started a vertical descent to coil the long-line, still with the smoking tail rotor.

In that accident, the tail rotor, the whole 90 degree gear box, departed. We found that the six studs that held the 90 degree gear box had failed catastrophically. We saw that there was high heat and abrasion at the output quill, which was probably the source of the smoke. The movement of the studs was backing the unit out, with loss of oil and heat buildup. That's why we saw some scoring and the smoke was coming from oil heat coming out.

UNIDENTIFIED VOICE: On the next to the last slide (Figure 10) you showed, did you say that the pilot survived the impact of the crash?

MR. HERLIHY: Both of those individuals walked away, or crawled away. They were hurt. That was engine failure.

MR. JIM LEMATTA (Columbia Helicopter): On that 214 accident where the log and the long-line hung up, was it determined that they punched it off, or not? Was there an O or a D-ring or a shackle, or was it a swedge that was in the hook?

MR. HERLIHY: Swedge clevis is a loop, like a teardrop loop, that's swedged in.

UNIDENTIFIED VOICE: It's put in by the manufacturer of the cable.

UNIDENTIFIED VOICE: Or a thimble.

UNIDENTIFIED VOICE: That's a thimble, not a clevis.

MR. HERLIHY: Yes. I call it a clevis. To answer your question on the belly hook, we had a mechanic out there by that time, and we brought out that hook, among other parts that we brought back. We hooked up a battery to that hook and we got it to trigger effectively. It was electrically fine, and mechanically fine.

The cockpit was so damaged that we could not recreate continuity between any part in the cockpit, either mechanical or electrical, to that switch, so I don't know whether it was hooked up correctly or not. I can't rule out that it wasn't working. Now, why was it closed and the swedge outside? The most probable scenario that investigators have to go on is that it was never punched off. The pilot may have suffered from task overload. There's not a person in this room who doesn't believe that these guys were overloaded in tasks at that point, with a helicopter that was coming out of the sky. Perhaps they never got to it. When the impact occurred there's a lot of twisting, moving, pulling, ripping, and compression, as you know, that happens in a few microseconds in all of these systems, and either electrically or mechanically the hook opened. We have noted, in flight data recorders and cockpit voice recorders, that there's a huge electrical spike that goes through the electrical system at impact. Those surges may have caused electrical energy sufficient to open the hook. An alternate explanation is that the pulling and stretching of the mechanical kick out switch, as it's connected cable-wise to the hook, also could have been actuated. There's a possibility that the hook was carried closed.

But there may be another explanation. Unlike other hooks, perhaps the hook used in this operation opened to some degree short of 90 degrees down. Would it have released? Probably not, when the helicopter is in forward flight with tension at approximately a 30, 35 degree drag angle on the cable as it's pulling these logs behind. We found that in that particular hook there was a wearing notch, which is quite normal. We looked at other ones that wore a notch in the hook. Had the thimble been hooked in that wearing notch, it would have been directly under the center of that hook, even with the hook down and fully open, the part design would not have allowed the hook to slide off. It may have slid off if the helicopter was in a hover, and there was dead load on it, but not in the dynamic condition that occurred following the loss of control over the log yard.

I presented both scenarios as food for thought for you in the industry to say, hey, could this happen? Could we have a pilot attempting to jettison from a belly hook that will only open 70 or 80 degrees down? Efforts to discuss this event with the manufacturer were not successful.

UNIDENTIFIED VOICE: Another possibility would be that the thimble didn't come off of there clean, that it hung up on the closing. If the thimble wasn't of sufficient size, this might have been the case.

MR. HERLIHY: Thank you. I took a thimble the same size, and slid it easily on and off. It was large, twice the size of the hook itself. I didn't see any squeezing. That thing would easily just slap right on and off. I talked with engineers in Washington to see what their best guess of restriction or constriction would be under dynamic loads, because we have no way of dynamically testing either that thimble or the hook. We just did it statically. Does that mean it worked effectively under load? No. That does not mean that. I can't be certain of that, but that's as far as we could go.

UNIDENTIFIED VOICE: I think most of the pilots here would agree that they don't open if you get them too heavily loaded.

MR. HERLIHY: In this scenario, witnesses said that at the onset of loss of control over the dump there was no load on it, and that may be a problem, too. It was slack. The load was absent all the way around until the pilot started picking up the slack. So, there was an immediate strain on that thing. During the period of the time where jettison activity could have occurred, there wasn't high strain. We just can't say for certain what occurred.

UNIDENTIFIED VOICE: A logging pilot's typical reaction would be to attempt to jettison the log first, not the long-line.

MR. HERLIHY: Using the remote.

UNIDENTIFIED VOICE: The lower hook.

UNIDENTIFIED VOICE: I talked to some of the crew who were on the ground when that crash occurred. From what they said, it appeared that either the hook was on the ground or that there was a great deal of slack in the choker. You have a spring return on your load beam, so you can hit that button, release your solenoid, and if it doesn't have a load on it of some sort, just the weight of the choker to spit it, the choker will remain in the hook. It's very likely that these fellows thought they had released the load. As they were dealing with this malfunction of the aircraft, it came tight on them.

MR. HERLIHY: There are a lot of unknowns that are part of this. We don't have a cockpit voice recorder, and for me to speculate on what was going on up there is not a professional approach.

DAY TWO

MR. MICHAEL KLATT (NIOSH): What we are going to do today is attempt to find ways to remedy the problem as stated in the problem statement: Workers involved in helicopter logging are at an increased risk of serious or fatal injury. The process we are going to use to address the problem statement is called brainstorming.

Brainstorming is a way of enabling a group of people to quickly generate, clarify, and evaluate a sizable list of ideas. This process consists of three phases; generation, clarification and evaluation. The rules of brainstorming are as follows:

1) Each person takes a turn, in sequence, around the group.
2) Present one idea at a time.
3) Do not criticize or discuss ideas during the generation phase.
4) It's okay to pass.
5) Build on the ideas of others.
6) List ideas on a flip chart visible to the group.

During the generation phase of brainstorming, the emphasis is the quantity of ideas, not the quality. During the clarification phase of brainstorming, the team reviews the list of ideas to make sure that everyone understands them and to eliminate duplications. During the evaluation phase, the team reviews and discusses the list of ideas to eliminate irrelevancies. After the brainstorming process, the team will multivote to reduce the large list of ideas to a manageable number.

We will divide into four teams with the following focus areas:

1) Environment and communications, with Mr. Jan Manwaring as group leader.
2) Equipment and human factors, with Mr. Doug Herlihy as group leader.
3) Management and oversight, with Mr. Mike Barr as group leader.
4) Maintenance and training, with Dr. Rob Bertoldo as group leader.

Each team will brainstorm the root causes of the problem statement and the countermeasures to these root causes. At the end of the day we will all gather back together again and have each of the four team leaders share their team's recommendations with the rest of us.

I know some of you have a concern with the wording of the problem statement. Therefore, I will let Dr. George Conway, the medical epidemiologist in our office, comment on the wording of the problem statement.

DR. GEORGE CONWAY (NIOSH): We know, based on our surveillance, that being a pilot, or being associated with helicopter logging operations during the first half of this decade in Alaska has carried a substantial risk. The death rates are high. They're also very, very high for logging. Overall, loggers in Alaska risk dying at rates around 200 to 300 per 100,000 per year. So, two or three in 1,000 Alaska loggers are killed every year, on average, and some years it's much worse than that. The worst year in recent past was '92, because of the large number of logger deaths associated with the Hobart Bay helicopter crash.

We don't seek to argue whether being associated with helicopters versus routine logging is more hazardous. Frankly, from my perspective, and looking at the industry statistics, all operations associated with logging are much more hazardous than being an accountant, or working in a foundry, or whatever a lot of other Americans do for a living. Combining hazards of logging and aviation makes for a relatively dangerous job.

From an epidemiologic perspective, logging is definitely a risky business, but it's not limited to helicopter logging, and our experience with helicopter logging being uniquely hazardous is time-limited. It's limited to 1990 through 1993 in Alaska. Now, I know a lot of you have come from outside Alaska. Most of you have spent time in Alaska. if you don't live here now. But the perspective from outside is that helicopter logging is not relatively hazardous compared to general logging, and while I think that's supportable in Oregon and Washington it isn't here.

I suggest we slightly modify the problem statement to say that "workers involved in helicopter logging are at risk of serious or fatal injury." Then we can focus on doing what we can to make these operations safer than whatever each of us perceives they are currently.

I want to get into a little background on our office, and why we worked with the Working Group to convene this meeting. NIOSH, the National Institute for Occupational Safety and Health, is part of the Centers for Disease Control, which is part of the U.S. Public Health Service. We're not a regulatory organization; we're a research organization. And the way we work is by doing public health surveillance and by designing and carrying out preventive strategies. As the United States has matured, things like clean water and immunizations have become readily available, thus the things that kill people in the United States have changed. The main killer of children and younger adults in the United States now is injury. Not just on the job, off the job; automobile crashes still kill a tremendous number of people.

We knew that adult passengers and kids were at risk of being killed by ejection from cars and wrecks because of surveillance, with the lead from the National Highway Traffic Safety Administration. So, in the 1970s, seat belts and children's car seats were introduced in the U.S. There are seat belt and car seat regulations in most states, and all U.S. autos now come with seat belts. The risk factors were identified through surveillance but the regulations were decided by state legislatures on a state-by-state basis.

What we seek to do here is take surveillance information and use it for action. One of the currents yesterday was that many of you stated that you didn't want to have new rules and regulations. There seemed to be the attitude that if a government agency or agencies got involved in putting on a meeting like this, then the goal was to come up with some new rules and regulations. On the contrary, our strategy is to do our best to avoid new rules and regulations in general, because they're too slow, they're not flexible enough, they require additional resources to enforce, and inevitably they end up with loopholes in them. For all those reasons, that is not the intent of our group being here. The intent of our group being here is to pose our perception of the problem, that this is a dangerous job, and to foster action to do something about this problem.

One other term that there was some concern about is that helicopter logging is an emerging industry. The reason we used that term is that helicopter logging has been perceived by economists and forestry management as being the minor part of log-harvesting operations through the very early 1990s. Current projections are that helicopter logging may be the dominant form of harvesting timber by the end of the century, because of economic changes, changes in the industry itself, and environmental regulations. You all are the vanguard of the industry, and to a lot of you this is now old hat. Some of you have been working in this area for 20 years. That is not the case, overall, for forestry management and logging. Heli-logging is now progressing from being what's regarded as a minor sector within the logging and timber industry to possibly being the dominant means by which logging is conducted by the end of this century.

What we wanted to do was seize the opportunity of a potentially very isolated series of events in 1992 and 1993 in this state, take that experience and try to get the best understanding of why that happened, and use that to work with all of you experts in coming up with a good plan and agreement among us about how to prevent that happening in the future. And I think that in the long run that will contribute greatly to the economic security and viability of what you all do for a living as well.

So, our concern is not declaring an emergency and getting people in trouble, but to use this series of events to prompt us into some sort of action that eventually will save lives.

MR. LASH LAREW (ERA Aviation): There is reason for concern right now in the United States, because of what's happening with commuter airlines. I mean the government's come in and they've said they want to make everything okay.

You know, the reason for this concern, the reason people are here, is because there is a genuine concern about regulations. And it's happening right now in the commuter airline industry. For a very long time I was part of the commuter airline accident prevention committee that was established and chaired by the Alaska Section of Epidemiology. The committee was formed because of all the commuter airline and Part 135 accidents in the State, mostly fixed wing. We came out with a little card for passengers and that was about the sum total of the whole program.

DR. CONWAY: The "fliers' rights card"?

MR. LAREW: Right. But the point is, that was a valid card, and it was good for the people that were using it. But there's a lot of genuine concern amongst operators about regulations. And it's not unfounded. Right now, in the United States, we're going through the same thing, where there's a knee jerk reaction because of an accident, right? And we've got to do something.

So, what are we going to do after everybody's under Part 121 and we have an accident? What are we going to do then, quit flying?

DR. CONWAY: I cannot say that we can protect you from all new rules and regulations. What I can tell you is that experience in industry in general in the United States is that where industries have voluntarily developed their own standards and shown that by abiding by them they can make their operations safe, then that greatly reduces the likelihood of having problems with something that's an unpalatable regulation.

In a worse case scenario, if you were to have regulations developed, which, once again, I'm not pushing for because, from my perspective, something that takes ten years is too slow, the horse is already going to be out of the barn. This is going to be a really big industry in the next five or six years. A lot of you are going to make a lot of money and be real busy the next few years. That will all happen long before any regulations could be promulgated, implemented, et cetera. We know that voluntary standards, like the ones the Society of Automotive Engineers have implemented over the last 20 years, do work. When I was a teenager, 25, 30 years ago, we thought of throwing a rod as being a relatively common event. I haven't heard of that happening in an automobile in 15 years. The Society of Automotive Engineers introduced the voluntary standards that resulted in these improvements. Engines work a lot better in automobiles than they did a few years ago. They used to wear out at 60 to 80,000 miles, now many go 130 to 180,000 miles without major problems. I don't think policing is as much the idea as having good standards. I don't want to put the FAA folks that are here on the spot, but I would think all of the regulatory agencies would be very receptive to measures enhancing safety, that this industry would take on its own initiative.

The other important thing is that the mood right now in Congress is not pro-regulatory. It is anti-regulatory. So, if I had to make a trend projection on rules and regulations, I would say that they are probably going to decrease.

MR. LAREW: But again, the point is, when the commuter airline thing came up, it was the lack of enforcement of current regulations that caused a lot of the problems. What caused the accidents and the deaths were people operating against the current regulations that were in force. They weren't being enforced by the local FAA for whatever reasons. It doesn't make any difference what the reason is; that's what was happening. We have the same thing here. We have a little blip in the logging industry, where there's accidents and deaths, during a short period of time.

DR. CONWAY: My interpretation of the surveillance data is that helicopter logging is another dangerous part of logging operations. Now, I don't think that they're egregiously higher than other logging operations, but, from our perspective, the death rate in logging in general in Alaska is unacceptably high, just as it is in fishing; just as it is in general aviation. My interpretation of my job is to prevent most of those deaths in the future, and to turn that around by the end of this decade.

MR. LAREW: You can't prevent bad business practices. You can't regulate away bad business if there's already appropriate regulations in place. That's the point I'm trying to make here. Having voluntary standards that everybody agrees to, or that most people agree to as being worthwhile, would be a big step in the right direction for prevention.

As far as restraining other operators who have bad operations, there are ways of doing that other than regulatory, including bringing suit against them. The statistic that Columbia gave yesterday was 112,000 hours accident-free. Compare that to the rest of the helicopter logging operations in Alaska.

DR. CONWAY: Our understanding is that Columbia is an exemplary operation, and one of our staff, Jan Manwaring, recently took a senior Malaysian public health official to some of Columbia's sites to observe their operations here. We don't dispute that this is an industrial process being carried out on a large scale with relative safety. But, we have also seen that not to be the case.

MR. LAREW: It's like you're lumping this logging problem. That's the same thing that was done with commuter airline crashes. You had Part 135 operators that were taking off from the beach and they were overloaded, had too many people in the aircraft, crashing. But it was all lumped in with the scheduled commuters and everything else, and we had this big problem where the real problem was regulatory. When I say we, I'm talking about the commuters in Alaska.

MR. DOUG HERLIHY (Former NTSB Crash Investigator): I'd like to say something about the commuter parallels that Lash Larew brought up. I was part of the commuter study in the United States, being an ex-commuter pilot and an investigator. There are some problems in commuter airlines, and the position that Lash takes is the same position as the Regional Airlines Association, that there's nothing wrong with the commuter industry, and yet there is five times the likelihood of accident in the commuter industry. Some problems in the commuter industries need to be addressed, and that deals with decision-making caused by the flight time, flight and duty time anomalies that we see in commuter operations.

Presently, under Part 135, the commuter scheduled operations, the airline operators are allowed to have the pilots move away from the airplane for eight hours of rest and back into the cockpit with no regard for the travel time to hotels, standing at the desk and getting nourishment, or other basic needs. We find in a great number of the commuter accidents that occur that decision-making is the underlying problem area. Decision-making as it is affected by fatigue is certainly an issue that we should address, and so that was the thrust of the NTSB looking at the commuter industry, and it needed to be done.

It's not a knee jerk reaction, and I take issue with that knee jerk reaction statement. We do have commuter accidents at a high rate, and that's why we work in the commuter area. So, I think we ought to set that part of the record straight.

MR. PAUL MAVRINAC (Canadian Aircrane): We have 12 heavy lift aircraft in Canada working at this time, four mediums, and soon to be some Kamans. There were six heli-logging crashes last year. Two on flat ground with the 204s and 205s, and a host of support aircraft that went down last year. So, this conference is not a knee jerk reaction. There are heli-logging crashes that are taking place not just in Southeast but also in Canada.

Last year Transport Canada came out with a draft paper that I'd like to read to you, which is very interesting. This draft paper was in restricted category in the growing heli-logging in British Columbia.

It says, "It could be concluded that the safety responsibility of Transport Canada should be biased towards large passenger air operations, and that other activities must be evaluated for the level of risk using the probability of failure and impact assessment approach."

They go further to say, "In view of the above, and the fact that no passengers or innocent bystanders were killed or injured, this type of operation must be rated as a medium risk but low impact. As a consequence, the use of a lengthy, expensive, and involved certification evaluation is a difficult exercise to justify on cost-effective grounds."

This is from our own Transport Canada that came out because of the growing number of heli-logging operators, and of course there's three operators here that have operations in Canada. There are three Canadian aircraft that are logging here right now, and there's probably three within 100 miles of this city. So, I think it's something that has to be thought of on both sides of the border.

After this year, any Canadian operator will be able to come into Southeast, and any American operator can come to B.C. Who is going to regulate those people? The FAA is not going to come into Canada to monitor an American operator, and certainly the MOT isn't coming to Southeast, because they can't afford to. So, when we talk today, I'm sure everybody has operations on both sides of the border, let's consider this border issue.

DR. CONWAY: What I would really challenge everybody to do is everything that you can to be creative in how to ensure you all make it home every night for the rest of your career, and the same for your staff.

I don't want to close the door on any options at all. If you feel that some other regulations or more vigorous use of existing regulations is a possible solution, please say so. We don't want to foreclose that, but the potential means of dealing with this problem are very, very broad; ranging from dealing with the equipment, different equipment or better equipment; the practices, and what you all regard, among yourselves as colleagues, as the right way to do this.

The only reason I started out with my comments today was so people don't spend their whole day and, from my perspective, waste it on discussing regulation. Everybody's concerned about that impact, but I encourage you to think and act as broadly as you can, and think about as many different ways of ensuring the safety so that you all get home, and so that your crews get home. That's the bottom line for us. Thanks.

MR. GEORGE WARREN (Columbia Helicopters): I think that's fine that you're rephrasing your premise here, but I can't get away from the nagging idea that the question is being vague. One of the things we saw yesterday up on one of these overheads, that I think is tremendously significant, is the fact that after these accidents occurred, and the government makes this point themselves, they increase their oversight, and guess what? The incidents stopped.

I'm perfectly willing to accept responsibility for improving the heli-logging operation from the contractor's standpoint, but I think it would be perfectly appropriate if all the bureaucrats in this room got together and talked about how implementation of existing rules could be improved to make the situation better, as well as our getting together and talking about ways that we can make it better.

DR. CONWAY: I think actually one of the things that would be very worthwhile today would be guidance in how to do that. This is an opportunity for you all to provide guidance in how to do that.

MR. WARREN: We can get together and we can talk about all the things that we think need to be done to make it work better. The only thing is, that if we had done this three years ago, the people involved in these incidents probably wouldn't have been participating in whatever bright ideas we come up with. That's to say we can't be responsible for everything. I mean we'd like to. We'd like to have it in our power to be able to control everything, but we can't. That's why we have regulators.

DR. CONWAY: One of the problems though is that what the bad apples do affects directly the perception of the industry, and affects your underwriting. Greatly drive up your business costs. And there are businesses where the underwriting experience has been so bad, the crab sector of commercial fishing is one example of that, it's almost impossible to do business because of the underwriting cost.

This is a problem that inevitably is going to affect the good guys, whatever the bad guys do. I don't have the answer to that. But this is a problem for everybody in the room, and all we want is for people to share what they believe to be the root causes and possible countermeasures.

MR. BILL HACKLER (Siller Brothers): To put it in medical terms, all of us, every once in a while, get a physical. And if you don't find anything, you just do it once a year or once every three years. Using Columbia an example, they have a physical and they've been pretty healthy for ten years, 110,000 hours. So they just go about their business. They have a physical, they don't have a problem.

Some other operators, a couple of them that shall be nameless, maybe they came up with a problem during their physical, and, as a physician, when you find a problem during a physical, you go a little more in depth into that problem, and you keep poking away at it until you either solve it or the patient dies. This really is a fact.

What I'm saying is, as an industry, maybe what we need is for the existing regulatory agencies to give us operators that have a good record, a physical every once in a while, and not disrupt our operations. We could all take that. And if you come up with something, go at it with both feet and keep an eye on the patient or the operator until they're either healthy or gone. All of the things that are necessary to do that are in place now. Instead of wasting all of our resources on all of us, put the resources where they would do all of us the most good. When somebody new comes in with a single-engine helicopter, give them a real thorough physical and keep an eye on that patient. If you've got somebody like Columbia, give them a physical every once in a while and you leave them alone, because they're a waste of the regulator's time.

What I'm saying is, what's necessary to address these problems are already in place, but the resources that are there now have to be aimed a little better.

MR. TIM HARPER (Erickson Aircrane): I have to tell you, Doctor Conway, that I find your argument specious. I truly do. No offense.

Yes, there is going to be some limitation to underwriting. That has nothing to do with the helicopter logging industry. It's got to do with the airline industry, as a matter of fact. The fact that the London market has taken some hits has nothing to do with helicopter logging. It has nothing to do with the operators that came into your little area and caused big problems. And it basically has nothing to do with our industry. Our industry is safe, it is professional, it is efficient. It's the safest way to log.

What we're trying to do is let you know that when we came up here we read statements that said, past experience has shown helicopter logging to be a very dangerous activity, period. Not in Southeast, not in comparison to logging, not in comparison to anything else, but of and by itself. And what we're saying is, we believe that that statement is incorrect. What we're saying is, that we believe yes, the insurance market is going to somewhat regulate it. And yes, operators like Columbia, operators like Erickson, who have been around and who have excellent records, still can get [insurance] written in London. You know, our lead underwriter no longer takes the lead on aviation accounts. They still take the lead on ours. Our American underwriters have come to us and asked to take greater parts of our risk, because we're a good risk. We have a history that shows that. You know, we go way beyond the maintenance standards. Why? Because we know that safety is economically viable.

What people have been trying to do is to counteract what we came up here and found. What we're trying to let you know, and what a lot of this has been about is, yes, there are legitimate operators in our industry, and yes, there are some not so legitimate operators. And the numbers are going to be driven by those not so legitimate operators. Our principal operation inspectors, and the FAA, have a regular interface. I'm sure they do with Columbia, too. They come down all the time. We have scheduled meetings. If we have problems, we call them up and we discuss it. You know, what can we do better? What are we doing here? How does this work? What's not happening, and that was one of the things that he was just covering, is that the agencies that are passed with this public trust ain't doing the job.

There's a thing called the Sherman Act in the law, okay? It's got to do with antitrust. We can't band together and drive these other people out of business. That's against the law. The Sherman Act precludes it. So, we're limited in what we can do. Yes, we can promulgate standards. Yes, we can do certain things. But we can't go out there and tell some operator, you're not doing it the right way, you can't helicopter log. Or else they'll sue our pants off, and rightly so.

DR. CONWAY: I think all the points that you make are really good, and I acknowledge them, and we should have been more specific. The numbers that we have are Alaska-specific. There aren't good surveillance data for the rest of the country. So we really can't argue that, because neither of us have the numbers to do it.

What I'd get back to is that we know that there have been some very bad experiences with this in Alaska. We all agree that there have been some potentially bad players involved in doing that. We understand, and it sounds like we all agree, that there are limitations to what regulation can accomplish and limitations to what your industry can do. And what we ask of you all here is to show leadership in this and to provide feedback, and you have an opportunity to get that down in writing. This will come out as part of our Working Group, this won't be an official government criteria document or something like that, that'll be poured over for 35 years. This will be just a workshop result, but it will be circulated to as high a level as we can persuade to read it, and it is an opportunity for you all to speak with a clear voice about what you think works and doesn't work.

This is a great opportunity for some sort of voluntary inspection like the Coast Guard has. Something that could functionally be a prototype like that for a volunteer inspection program. One of the potential contracting criteria that could be of assistance in the future would be that so and so had a recent successful voluntary inspection, like some of the companies and processors are doing. Asking USDA to inspect their fish and whatnot long before there are any regs on that.

I think these are really good points. We didn't mean to say that you shouldn't be doing what you're doing or that it's egregiously hazardous elsewhere. We don't have any data about that one way or another. What we have done is asked you all for help in dealing with our mission, which is to ensure the safety of Alaskan workers. And we recognize that there's a great deal of experience in this room. And that provides a real opportunity. My only concern is that that opportunity not be squandered by squabbling over one or two points that I think we can leave in abeyance and still proceed.

MR. ROY FOX (Bell Helicopters): I'd just like to throw a comment in that there's not a person or organization here that doesn't have a bit of dirty laundry, and there seems to be a lot of finger pointing. I don't think that there is any one problem here that we're trying to address. There isn't any one solution to the problem, okay? There are many little things.

One of the biggest things is, where is heli-logging in Alaska compared to other areas? I don't think it's going to be as bad as they said to begin with, but you don't know. You don't have a way of proving it. I feel that you need to set up basically some kind of operators' organization and start working on the issues by setting up their own, and I'm going to use the word standards lightly, because only if you're inside that organization can you do it. This same group could then work with these other areas to address the issues of very limited FAA oversight, and the fact that they're not following their own rules, and all these other issues. But I think it's a combination of things. And unless you start working together now, when the next big accident occurs, this room won't be big enough to hold the next meeting. So, you better start working a little bit together and work on all the issues slowly.

DR. CONWAY: Just to recap, there are two goals. One is to identify the specific problem areas that you all feel that work needs to be done in, and come up with as many countermeasures, as many steps, toward dealing with those as possible; and the other thing that you all should be thinking about is, after we go through that from each group, the next thing we're going to discuss is commitments. That is, what each of you is willing to do to work on some portions of the recommendations. Whatever you find attractive and what things you want to jump into, whether as part of an ongoing working group, or whether it's writing something up or researching something, or some much more active thing. Please go with your group leaders and be back here at 3 o'clock. Good luck.

MR. KLATT: (3:00pm) Welcome back. I hope you found this process of some value. Let me go over the recommendations of each group.

RECOMMENDATIONS FROM SUBGROUPS TO IMPROVE SAFETY IN HELICOPTER LOGGING

Equipment

The use of multi-engine helicopters is recommended for aerologging.

The design, weight & balance, and operating limitations established by the manufacturer must not be exceeded.

Aerologging equipment and components should be certified by the FAA, and overhauled in accordance with the manufacturers documentation or manuals.

Maintenance

The aerologging industry should establish standards for sound maintenance procedures.

Adequate facilities should be available for the level of maintenance to be accomplished.

An FAA-approved maintenance program should be established.

Only FAA-approved parts should be used.

All flight-critical components should have accurate historical records.

All maintenance work should be inspected prior to sign-off by certificated authority.

Human Factors

The use of a qualified second pilot is recommended for aerologging.

Companies should develop and publish standards for maximum flight and duty time.

Companies should establish and enforce standards and methods to monitor unsafe attitudes and unsafe types of competition.

The use of drugs and alcohol in aerologging should be prohibited, and aerologging camps should be dry.

There should be random drug and alcohol testing in the event of a mishap.

The FAA should not be permitted to sanction, by way of irrevocable certificate action, those individuals entering voluntary drug and alcohol rehabilitation programs.

It was also recommended that NIOSH conduct or sponsor a study of cockpit environment design for improvement of comfort and safety, and chronic injury reduction.

Training

Helicopter model-specific and flight-specific training should be provided for aerologging operations.

Flight and ground crew coordination training should be provided for all aerologging crews.

Companies should provide maintenance training in specific helicopter models, special inspections, and documentation of maintenance operations.

Companies should provide recurrent documented training for flight crews and mechanics.

Management

An aerologging association should be established to serve as a forum and spokesman for the aerologging industry.

Companies should be encouraged to develop a strong safety culture within upper level management.
Mid-level managers should be trained on the concepts and responsibilities of developing a strong safety management culture.
Employees should be encouraged to report safety violations without fear of punishment.
Companies should specifically designate a safety manager, with a specific job description.
The safety manager should receive formal training on a continuous basis.
Companies should establish an employee/management safety committee.
All employees should participate in the management of safety.
Company officials and employees should be made aware of the cost-benefits of an accident-free operation.
Companies should establish task termination safety rules.

Oversight

FAA must promptly enforce all known rule violations.
Staff of all local FAA Flight Standards District Offices (FSDO's) should be trained in all pertinent aspects of aerologging operations.
Companies should be required to give prior notification to the local FAA FSDO's concerning any proposed helicopter logging operations in their service area.

Interagency/Company Cooperation

Establish a helicopter logging association and encourage membership.
Companies should establish communication between each other when conducting aerologging operations in close proximity.
Companies conducting aerologging in the same areas should establish joint EMS and emergency action plans.
Companies and agencies should develop and disseminate a contractor's safety check list.
Companies and agencies should assist each other in writing and disseminating incident and accident reports.
Companies and agencies should develop and disseminate Standard Operations Procedures manuals.

Environment

Companies should provide improved and continual training concerning environmental hazards for all helicopter logging crews.
Companies should establish improved communication and educate U.S. Forest Service, state agencies, and environmental group personnel concerning the necessity of more adequate helicopter emergency landing zones, and concerning the potentially hazardous combination of danger trees and rotor downwash.

MR. KLATT: These are the recommendations of the Helicopter Logging Safety Workshop as they will appear in the Proceedings of the Helicopter Logging Safety Workshop.

If you have a minority opinion contrary to one or more of these recommendations, please submit it to me and it will appear in the Proceedings without comment. Once the Proceedings are published, they will be shared with industry, government and academia.

As I look at the Purpose for this workshop as stated on page one of the agenda, I believe we were successful at increasing awareness, building cooperation, sharing information and experiences, and encouraging action to prevent injuries that result from working in the helicopter logging industry. Thank you very much for attending and for your participation.

Minority Report on Single vs Twin Turbine Issue

By Roy Fox, Product Safety Chief, Bell Helicopter Textron, Inc.

Several people within the group were strongly opposed to the group recommendation that only twin-turbine helicopters be allowed to log. The people against this recommendation represented the only three helicopter manufacturers in attendance of the workshop. Such a recommendation (even if founded) can have serious consequences in other states and other uses including external load operations. The safety problem is not related to counting the number of engines.

A previous study using NTSB accident data and FAA flight hours for the period 1984 through 1988, Reference 1, was done to compare the safety of single-turbine vs twin-turbine helicopters. The resulting Table 1 provides the accident rate for various causes for three types of helicopters and the Bell 206 single-turbine helicopter. The 206 was singled out as it is the predominant helicopter in the world. In the USA. for the above time period, the 206 flew 7,035,846 hours out of the total helicopter fleet (single-piston, single-turbine, and twin-turbine) of 11,439,214 hours or 61.5%.

TABLE 1. U.S. Registered Helicopter Accident/100,000 Flight Hours

Type of Aircraft	Engine Only Airworthiness	Non-Engine Airworthiness	All Airworthiness	All Causes
Single-Piston	1.99	2.09	4.09	17.83
Twin-Turbine	0.35	1.25	1.59	4.37
Single-Turbine (All)	1.08	0.61	1.69	5.49
Model 206 Only	0.88	0.17	1.05	4.28

Thus, if one is only concerned with a engine failure, the twin is an obvious choice. However, if one is only concerned about components-other-than-engine failing and causing an accident, a single- turbine is the choice. Since one cannot pick the cause of the accident, we should be concerned about all causes, not just engine. In most twins, an engine failure at an Out-of-Ground-Hover at maximum load will likely still result in a controlled crash. The Risk of Serious Injury (RSI) is the occupants risk of a major or fatal injury per 100,000 occupant hours of exposure. Considering all airworthiness failure accidents (engine and non-engine parts) from Table 1, an occupant's risk is the same in single-turbine and twin-turbine helicopters as shown in

Table 2. Occupant risk in a single- turbine Model 206 is about half that of riding in a twin-turbine helicopter. The 206 is a very simple (not complex) and reliable design.

TABLE 2. Occupant Risk of Serious Injury per 100,000 Occupant Hours

Type of Helicopter	Occupant RSI/100,000 Occupant Hr.
Single-Piston	0.98
Single-Turbine (All)	0.40
Twin-Turbine	0.40
206	0.21

Reference 1: Fox, R. G., Measuring Risk in Single- and Twin-engine Helicopters, AHS, February 24, 1992.

Morbidity and Mortality Weekly Report July 8, 1994/Vol.43;No.26

Risk for Traumatic Injuries from Helicopter Crashes During Logging Operations - Southeastern Alaska, January 1992-June 1993

Helicopters are used by logging companies in the Alaska panhandle to harvest timber in areas that otherwise are inaccessible and/or unfeasible for conventional logging (because of rugged terrain, steep mountain slopes, environmental restrictions, or high cost). The National Transportation Safety Board (NTSB) investigated six helicopter crashes related to transport of logs by cable (i.e., long-line logging*) tł occurred in southeastern Alaska during January 1992-June 1993 and resulted in nine fatalities and ten nonfatal injuries. This report presents case investigations of these incidents.

Incident Reports

Incident 1. On February 23, 1992, a helicopter crashed while transporting nine loggers. The copilot and five loggers died; five others were seriously injured. The NTSB investigation revealed that a long-lin attached to the underside of the helicopter became tangled in the tail rotor during a landing approach, causing an in-flight separation of the tail section (1). Passenger flights with long-line and external attachments are illegal (2) and violate industry safety standards.

Incident 2. On March 6, 1992, a helicopter crashed while preparing to pick up a load of logs with a long-line. The pilot and copilot were seriously injured. According to the pilot and copilot, the engine failed, and the pilot immediately released the external log load and attempted autorotation†

Incident 3. On November 10, 1992, a helicopter crashed while attempting to land at a logging site, sustaining substantial damage. The solo pilot was not injured. NTSB investigation revealed that the helicopter's long-line had snagged on a tree stump during the landing and that the company had no documented training program (1).

Incident 4. On February 19, 1993, a helicopter crashed from a 200-foot hover after transporting two logs to a log-drop area. The pilot and copilot were killed. NTSB investigation revealed in-flight metal fatigue of a flight-control piston rod.

**A typical long-line logging helicopter carries an approximately 200-foot load cable (i.e., long-line), which is attached by a hook to the underside of the helicopter. A second hook is fixed to the free end of the cable, where a choker cable (an apparatus designed to cinch or 'choke' around suspended logs) is connected to one to four logs per load.*

† Autorotation allows a helicopter to make an unpowered descent by maximizing on the windmilling effect and orientation of the main rotor-forward airspeed and altitude can be converted to rotor energy to reduce the rate of descent. Successful autorotation depends on helicopter airspeed and altitude when the maneuver is attempted (3). Most helicopters conduct long-line logging operations with minimal or no forward airspeed at less than 400 feet above ground level, while optimal conditions for autorotation require an altitude of at least 500 feet above ground level and airspeed of more than 60 knots per hour.

Incident 5. On May 2, 1993, a helicopter crashed during an attempted emergency landing after using a long-line to lift a log 1200 feet above ground level followed by rapid descent to a 75-foot hover. The pilot died, and a logger on the ground was injured. NTSB investigation revealed an in-flight separation of the tail rotor and tail rotor gear box from the helicopter. The company had been using a flight procedure that would have heavily loaded the helicopter drive train (1).

Incident 6. On May 8, 1993, a helicopter crashed after attempting to lift a log from a logging site with a long-line. The pilot and copilot sustained minor injuries, but the aircraft was substantially damaged. NTSB investigation found that the engine failed because machine nuts had come loose from the engine or its housing and became caught in the engine. The helicopter crashed when the pilot attempted autorotation.

Investigation Findings

Statewide occupational injury surveillance in Alaska through a federal-state collaboration was established in mid-1991, with 1992 being the first full year of comprehensive population-based occupational fatality surveillance for Alaska. During the time these incidents occurred, an estimated 25 helicopters in Alaska were capable of conducting long-line logging operations; approximately 20 were single-engine models from one manufacturer (Federal Aviation Administration [FAA], unpublished data, 1993). Approximately 50 helicopter pilots were employed in long-line logging operations in southeastern Alaska (FAA and Alaska Department of Labor, unpublished data, 1993). Using these denominators, the events in this report
are equivalent to an annual crash rate of 16% (six crashes per 25 helicopters per 18 months), 0.24 deaths per long-line helicopter in service per year (nine deaths per 25 helicopters per 18 months), and an annual fatality rate for long-line logging helicopter pilots of approximately 5000 deaths per 100,000 pilots (four pilot deaths per 50 pilots per 18 months).[§] In comparison, during 1980-1989, the U.S. fatality rate for all industries was 7.0 per 100,000 workers per year; Alaska had the highest overall occupational fatality rate of any state (34.8 per 100,000 per year) for the same period (4).

According to NTSB investigations to determine probable cause, all six crashes involved "...improper operational and/or maintenance practices" that reflected a lack of inspections of long-line helicopter logging operations (1). In incidents 4, 5, and 6, investigative evidence also indicated that log loads routinely exceeded weight and balance limits for the aircraft. Following increased inspections, no additional logging related helicopter crashes were reported through June 30, 1994.

Reported by. G Bledsoe, Occupational Injury Prevention Program, Section of Epidemiology, Div of Public Health, JP Middaugh, State Epidemiologist, Alaska Dept of Health and Social Svcs; D Study, Labor Standards and Safety Div, Occupational Safety and Health, Alaska Dept of Labor; National Transportation Safety Board, Anchorage, Alaska. J Manwaring, G Conway, M Klatt, Alaska Activity, Div of Safety Research, National Institute for Occupational Safety and Health, CDC.

[§]These rates refer to the period of intense collaborative investigation (January 1992-June 1993) and may not represent incidence over a longer period of time; however, they accurately reflect the high risk of helicopter long-line logging during this period.

Editorial Note: The incidents in this report demonstrate that long-line helicopter logging is a technology application with an unusually high risk for occupational fatalities. General aviation regulations restrict the number of hours pilots can fly during given time periods; however, long-line helicopter logging involves carrying loads outside the rotor craft, and there are no legal limitations on crew flight hours. Although flightcrew work schedules and daily flight hours vary greatly by logging company, flight-crew duty periods can exceed ten hours per day for ten consecutive days.

Helicopter logging operations often place heavy demands on helicopter machinery and associated equipment. The highly repetitive lift/transport/drop cycles are frequently conducted at or beyond maximum aircraft capacity in remote areas, where rugged terrain, extremely steep mountain slopes (as great as 70 degrees), and adverse weather conditions prevail. Complex operations under such circumstances may increase the likelihood of both human error and machine failure (5). In addition, conditions are unfavorable for successful autorotation during most helicopter long-line logging operations.

Regardless of where helicopter logging operations are conducted, the jurisdictional responsibility for inspection rests with the FAA office nearest the main or registered corporate office for the helicopter company (in all of the cases in this report, these offices were in the contiguous United States). This necessitates travel of great distances to conduct helicopter logging inspections, and remote operations may escape or evade inspection for long periods. The NTSB has recommended that operational and maintenance oversight responsibilities for remote sites be assigned to the nearest FAA office (1).

In response to these incidents, the Alaska Interagency Working Group on the Prevention of Occupational Injuries[¶], met in a special session on July 8, 1993, to discuss approaches for reducing the number of such crashes and ameliorating the outcome of crash injuries. Based on these and other findings, the working group made the following recommendations (6):

- All helicopter logging pilots and ground crews should receive specific training in long-line operations.
- Companies should follow all manufacturers' recommendations for more frequent helicopter maintenance (because of intensity of use) and for limits on maximum allowable loads.
- Companies should establish and observe appropriate limits on helicopter-crew flight time and duty periods.
- Companies should consider using multi-engine rotor craft.
- Specific industry wide operating standards and procedures should be developed.
- Companies should provide training in on-site emergency medical care for helicopter logging crews at all work locations.
- State, regional, and local agencies involved in emergency medical services education should make low-cost emergency medical training available to persons likely to work in a helicopter logging environment.

[¶] *Representatives from the Alaska Department of Health and Social Services, Alaska Department of Labor, FAA, CDC's National Institute for Occupational Safety and Health, NTSB, Occupational Safety and Health Administration, U.S. Coast Guard, and the U.S. Forest Service.*

- All flights over water should include appropriate survival equipment for all crew and passengers, who should wear personal flotation devices at all times during flights over water.

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STATE OF ALASKA

OCCUPATIONAL SAFETY AND HEALTH STANDARDS

ADOPTED BY REFERENCE UNDER
8 AAC 61.1060

ADDITIONAL LOGGING STANDARDS

DEPARTMENT OF LABOR
DIVISION OF LABOR STANDARDS & SAFETY

Published 7/31/95

Tony Knowles, Governor

(I) Employees shall not position themselves in the hazardous area near or under the loads or logs being lifted or moved. Employees shall not remain in the cab of a truck being unloaded if there is a danger of the load of logs striking the cab while being handled.

(J) Shear guards shall be installed on unloading machines and similar types of equipment on which the arms pivot and move alongside the operator creating a pinch point.

(K) Machines of the type having arms which block the regular exit in the up position shall have an emergency exit.

(L) Identification tags shall not be applied or removed unless logs are resting in a stationary resting place, such as bunks, cradles, skids or sorting tables.

(q) Helicopter Logging. (1) General.

(A) Helicopters must comply with any applicable regulations of the Federal Aviation Administration.

(B) Helicopters used for yarding must be equipped with a siren to warn employees of any hazardous situations.

(C) Before each day's operation, a briefing must be conducted, setting forth the plan for the pilot and the ground personnel.

(D) Good housekeeping must be maintained in all helicopter loading and unloading areas.

(E) Every practical precaution must be taken to provide for the protection of employees from flying objects in the rotor downwash. All loose gear within one hundred feet from the place of lifting of the load, depositing the load, and all other areas susceptible to rotor downwash, must be secured or removed.

(F) Employees may not perform work under hovering craft except for that limited period of time necessary to hook and unhook loads. Regardless of whether the hooking or unhooking of a load takes place on the ground or other location in an elevated work position, a safe means of access and egress, to include an emergency escape route or routes, must be provided for the employees hooking or unhooking loads.

(G) Riding the load or hook of a helicopter is prohibited except in the case of an emergency and with the proper safety gear.

(H) Static charge on the suspended load must be dissipated with a grounding device before ground personnel touch the suspended load, or protective rubber gloves must be worn by all ground personnel touching the suspended load.

(I) Personal protective equipment for employees working in loading and unloading areas must consist of complete eye protection, hard hats secured by chinstraps, and high visibility vests or outer garments.

(2) Ground Operations.

(A) If visibility is reduced by dust or other conditions, ground personnel shall exercise special caution to keep clear of the main and stabilizing rotors. Precautions must also be taken by the employer to eliminate, as far as practical, reduced visibility.

(B) No unauthorized person shall be allowed to approach within fifty feet of the helicopter when the rotor blades are turning.

(C) Whenever approaching or leaving a helicopter with blades rotating, all employees shall remain in full view of the pilot and keep in a crouched position. Employees shall avoid the area from the cockpit or cabin rearward unless authorized by the helicopter operator to work there.

(D) Sufficient ground personnel must be provided when required for safe helicopter loading and unloading operations.

(E) Signal systems. The employer shall ensure that the aircrew and ground personnel receive instruction on the signal systems to be used and that the system is reviewed with the employees in advance of hoisting the load. This applies to both radio and hand signal systems. Hand signals, where used, must be as shown in Figure N-1 of 29 C.F.R. 1910.183.

(F) There must be constant reliable communication between the pilot and a designated employee of the ground crew who acts as a signal person during loading and unloading operations. This signal-person shall be distinctly recognizable from other ground personnel.

(G) Ground lines. Hoist wires or other gear, except for pulling lines or conductors that are allowed to "pay out" from a container or roll off at the tree, may not be attached to any fixed ground structure, or allowed to foul on any fixed structure.

(H) Open fires must not be permitted in an area that could result in such fires being spread by the rotor downwash.

(3) Flight Path.

(A) A takeoff path from the log pick up point must be established and made known to all employees in the area before the first turn of logs is moved.

(B) The helicopter flight path to and from the landing drop zone must be designated and no equipment or employees (other than flight personnel necessary to assist in landing and takeoff) may occupy these areas during helicopter arrival or departure. A flag person must be stationed on each side of the flight path of a turn of logs where it crosses a road or the road must be closed to traffic.

(C) The approach to the loading and unloading area must be clear and long enough to prevent tree tops from being pulled into the landing.

(D) The helicopter must not pass over an area in which cutters are working at an altitude which would cause the rotor downwash to affect a cutter's ability to safely control a tree or cause dislodging of limbs.

(4) Delivery of chokers. Employees shall remain in the clear as chokers are being delivered. Under no circumstances shall employees move under a helicopter that is delivering the chokers or take hold of the chokers before they have been released by the helicopter.

(5) Log Pickup.

(A) The weight of an external load must not exceed the manufacturer's rating.

(B) Loads must be properly slung. Tag lines must be of a length that will not permit their being drawn up into the rotors.

(C) Pressed sleeve, swedged eyes, or equivalent means must be used for all freely suspended loads to prevent hand splices from spinning open or cable clamps from loosening.

(D) The helicopter operator shall be responsible for size, weight, and manner in which loads are connected to the helicopter. If, for any reason, the helicopter operator believes the lift cannot be made safely, the lift must not be made.

(E) All electrically operated cargo hooks must have the electrical activating device so designed and installed as to prevent inadvertent operations. In addition, these cargo hooks must be equipped with an emergency mechanical control for releasing the load. The hooks must be tested prior to each day's operation to determine that the release functions properly, both electrically and mechanically.

(F) Log pick up must be arranged in a manner that the hookup crew will not work on slopes below felled and bucked timber.

(G) If the load must be lightened, the hook must be placed on the ground on the uphill side of the turn before the hooker approaches to release the excess logs.

(H) Loose-fitting clothing likely to flap in the downwash and thus be snagged on the hoist line, must not be worn.

(6) Landing Drop Zone.

(A) The landing drop zone must be at least twice the nominal length of logs to be landed.

(B) The landing drop zone must be not less than one hundred twenty-five feet from the loading or docking area.

(C) The landing crew must be in the clear before logs are dropped.

(D) One end of all the logs in the turn must be touching the ground and lowered to an angle of not more than forty-five degrees from the horizontal before the chokers are released.

(E) Logs must be laid on the ground and the helicopter must be completely free of the chokers before employees approach the logs.

(F) If the load will not release from the hook, the load and the hook must be on the ground before employees approach to release the hook manually.

(7) Fueling.

(A) Separate areas must be designated for landing logs and fueling the helicopter.

(B) Under no circumstances may the refueling of any type helicopter with either aviation gasoline or Jet B (turbine) type fuel be permitted while the engine is running.

(C) Helicopters using Jet A (turbine kerosene) type fuel may be refueled with engines running if:

(i) No unauthorized employees are allowed within fifty feet of the refueling operation.

(ii) At least one 30-pound ABC fire extinguisher is within one hundred feet on the upwind side of the refueling operation.

(iii) All fueling employees are thoroughly trained in the refueling operation and in the use of the available fire extinguishing equipment they may be expected to use.

(iv) There is no smoking, open flames, exposed flame heaters, flare pots, or open flame lights within fifty feet of the refueling area or fueling equipment. All entrances to the refueling area must be posted with "NO SMOKING" signs.

(v) Before starting refueling operations, the fueling equipment and the helicopter are grounded and the fueling nozzle is electrically bonded to the helicopter. The use of a conductive hose is not acceptable to accomplish this bonding. All grounding and bonding connections must be electrically and mechanically firm to clean unpainted metal parts.

(vi) To control spills, fuel is pumped either by hand or power. Pouring or gravity flow must not be permitted. Self-closing nozzles or deadman controls must be used and must not be blocked open. Nozzles must not be dragged along the ground.

(vii) In case of a spill, the fueling operation is immediately stopped until the person in charge determines that it is safe to resume the refueling operation.

(viii) Ambient temperatures have been in the 100 degree F range for an extended period of time, all refueling of helicopters with the engines running become suitable to resume refueling with the engines running.

(D) Helicopters with their engines stopped while being refueled with aviation gasoline or Jet B (Turbine) type fuel must also comply with (i) - (viii) of subparagraph C.

(Eff. 12/6/95, Register 136)

50272-101

REPORT DOCUMENTATION PAGE | 1. REPORT NO. | 2. | PB97-151781

4. Title and Subtitle Proceedings of the Helicopter Logging Safety Workshop

5. Report Date 1996/02/00

6.

7. Author(s) Klatt, M. L., D. S. Hudson, and G. A. Conway, Eds.

8. Performing Organization Rept. No.

9. Performing Organization Name and Address Alaska Interagency Working Group for the Prevention of Occupational Injuries, Ketchikan, Alaska, March 1-2, 1995, Alaska Field Station, NIOSH, Anchorage

10. Project/Task/Work Unit No.

11. Contract (C) or Grant(G) No.
(C)
(G)

12. Sponsoring Organization Name and Address

13. Type of Report & Period Covered

14.

15. Supplementary Notes

16. Abstract (Limit: 200 words) These proceedings report the findings and outcomes of a workshop on helicopter logging safety in Alaska. The specific topics covered at the proceedings included the epidemiology of Alaska helicopter logging deaths, synthesis of the aircraft accident data involving helicopter external load operations in the United States and Alaska from 1980 through 1994, public health approaches to preventing helicopter logging injuries, helicopter logging from a pilot's perspective, alternative aerologging techniques, helicopter logging safety and the concerns of the manufacturer, weather and terrain hazards in helicopter logging, helicopter maintenance in helicopter logging operations, regulations and standards in external load operations, the business of helicopter logging, helicopter adaptations for external load operations, helicopter logging from a ground crewman's perspective, operational and aircrew factors in helicopter applications, and investigation findings of helicopter logging crashes.

17. Document Analysis a. Descriptors

b. Identifiers/Open-Ended Terms NIOSH-Publication, NIOSH-Author, Pilots, Logging-workers, Forestry, Mortality-surveys, Risk-factors, Aircrews, Accident-statistics, Safety-research, Accident-prevention

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages 128
	22. Security Class (This Page)	22. Price

(See ANSI-Z39.18) See Instructions on Reverse OPTIONAL FORM 272(4-77) (Formerly NTIS-35) Department of Commerce